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EFFECT OF BORON ON THE GROWTH OF CERTAIN GREEN PLANTS *

By ANTONIO RODRÍGUEZ GÉIGEL,**

INTRODUCTION

In recent years considerable attention has been given to the elements manganese, copper zinc and boron in relation to plant nutrition. Manganese has been definitely established as an essential element. The evidence for boron as an essential element is not as definite as the evidence for manganese but still it is fairly convincing. Like other elements boron at low concentration may increase plant growth while at higher concentrations boron is toxic. In general boron at concentrations in excess of one part per million has been found to be injurious to plants. This toxicity of boron is manifested by a distinct chlorosis of the leaves, defoliation and abscission of young fruits. Death may ultimately result from excess of boron.

Boron deficiency is of little practical importance in crop production, since there appears to be in most soils an adequate supply of available boron. Boron toxicity has been reported under certain conditions and is a problem of practical importance and may be a problem of greater importance than is generally recognized. Thus in Southern California and in the valley of the Río Grande in Texas, fruit trees have been reported as injured by boron. These conclusions are based on the character of the injury, i. e. chlorosis, defoliation and abscission of fruit and evidence on the presence in the plant and irrigation water of unusual amounts of boron. The fact that cholorosis is associated with boron injury suggests that boron interferes in some manner with the normal iron or manganese relationships. It further suggests that boron may owe its favorable effects on plants by counteracting or antidoting the toxicity of iron or manganese particularly the former since in general less attention has

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been given to the quantity of iron added to the culture medium than that of manganese.

This investigation is concerned with the toxicity of boron and more specifically with a possible relation of iron to boron. Three hypotheses have been advanced to account for boron toxicity. (1) Boron may have a direct influence on chlorophyll resulting in its destruction. (2) Boron may have an effect on iron which is essential for cholorophyll formation. The solubility of iron may possibly be decreased either in the culture medium in the soil, or in the plant. (3) There is the possibility also that in the presence of boron there is a decreased permeability of the cell to iron or a lesser accumulation of iron. Similar relations might hold with respect to manganese.

The problem of boron toxicity is one of theoretical as well as practical importance. Basic studies are essential for the development of practical method of control.

Review of the Literature

Boron seems to be widely distributed and probably occurs in all green plants. Wittstein and Apogier (**35**) in 1857 were the first to claim the presence of boron in plants. Baumert (**2**) 1888 detected boron in wines. E. O. Von Lippman (**20**) 1888 demonstrated its presence in the leaves and roots of sugar beets. Hotter (**14**) 1890 analyzed various fruits, leaves and twigs of certain plants finding boron present in apple, pear, cherry and others. H. Jay (**15**) 1895 analyzed various plants and concluded that boron is of universal occurrence in the plant world. He also stated that plants varied in their capacity for absorbing boron.

In recent years the problem of the stimulative action and the essential nature of boron has attracted the attention of various investigators. Nakamura (**25**) 1903 using peas and spinach in pots with soil found that the addition of one milligram of borax per kilogram of soil exerted a stimulant action while 5 milligrams had a slight depressing action. Agulhon (**1**) 1910 in his exhaustive studies using sand, water and soil cultures found that boron was beneficial for plant growth. Brenchley (**3**) 1914 using barley and peas in water cultures gave evidence of stimulation with the lower concentrations. With barley stimulation was not very evident. K. Warrington (**33**) 1923 in her extensive work on the effect of boron compounds on the broad beans and other plants, using water cultures, soil cultures, and field experiments, concluded that boron is an essential element. Warrington held the view that boron functioned catalyt-

ically in the plant. Plants showed variations as to the need for boron. Seasoned variation was important. Lack of boron affects meristematic tissues. Brenchley and Thornton (4) 1925 presented evidence to show that the absence of boron from the culture medium does not affect the entrance of the legume organism into the plant roots, but rather that gorwth of the plant without boron has affected the development of the nodules. The vascular supply of the nodules, was defective. Such nodules having no vascular strands remained small and buried in the cortical tissues. In nodules without vascular strands the bacteria do not give rise to bacteroid forms. There was a reduction in nitrogen fixation. Warrington (34) 1926 in her studies on the changes induced in the structure of *Vicia Faba*, by the absence of boron from the nutrient solution, found hypertrophy of the cambium, frequent disintegration of the phloem and ground parenchyma, and poor development of xylem with ultimate breaking of this tissue.

Sommer and Lipman (31) in 1926, using conductivity water and highly purified chemicals, presented photographic evidence showing that boron is essential for the growth of green plants. Brenchley and Warrington (5) in their study on the role of boron in the growth of plants reported complete failure of growth in the absence of boron. In the absence of boron, irrespective of the pH of the nutrient medium death ultimately occurred. They obtained better growth with a solution having a pH of 6.2. In their study on the influence of the concentration of boron on growth, they claim that the critical factor is the absolute amount of boron available in any one period and that concentration is not important so long as the rate of replacement is rapid enough to supply the required amount. A lower concentration of boron will suffice if the nutrient solution is frequently renewed. They stated that the form in which boron is present is of no importance and that sufficient amounts can be obtained from the insoluble borates. Boron could not be replaced by any other element and could not replace any of the essential elements. The authors claim that without boron, calcium is not fully utilized and that boron enables the plant to actually obtain more calcium or utilize it more efficiently in metabilism. Swanback (32) 1927 presented evidence indicating that boron is essential for the growth of tobacco. Collins (6) 1927 using sand, soil and water cultures claimed that boron is not necessary during the seedling stage. He obtained no stimulation by boron and concluded that boron is not necessary for the production of a mature soy bean plant. Johnston and Dore (17)

1928 from their study on the influence of boron on the chemical composition and growth of the tomato plant concluded that boron in concentration of 0.5 parts per million is necessary for the normal growth and development of the tomato plant. With a deficiency in boron they noted death of the terminal meristem and breaking down of conducting tissues in the stem. They found more total sugar and starch in the leaves and stems of boron-deficient plants and relate this to deficient conducting tissue. McMurtry (**23**) in 1929 corroborated the results obtained by Swanback. McHargue (**21**) 1930 also found a marked stimulation of growth with the use of boron. In a later paper (**22**) 1932 he describes special symptoms obtained with lettuce when boron was deficient. A. R. C. Haas (**8**) (**9**) (**10**) working with citrus trees has reported the necessity of small amounts of boron for their growth.

The various investigators who have dealt with the essential nature of boron have also studied the range in which boron is toxic. In general they have found that boron in concentrations above one part per million is toxic to plants. Such toxicity is marked by a chlorosis, defoliation and shedding of young fruits.

The problem of boron toxicity has become important in the dry regions of California and Southern Texas. Fruit trees of these regions have been affected with a chlorosis and final shedding of leaves and young fruits, thus causing damage of economic importance. The cause of this injury has been studied by various investigators. Kelley and Brown (**19**) found that boron is a natural constituent of the irrigation waters of Southern California. Subsequent investigations by Scofield and Wilcox (**26**) have confirmed these earlier reports and on the basis of their findings they concluded that boron is the cause of the injury to the crops of these regions. They stress the fact that the severity of crop injury resulting from boron may be influenced by local soil conditions, by climatic conditions, by method or quantity of irrigation and by the program of fertilization.

Skinner, Brown and Reid (**28**) in studying the effect of borax on plants made field experiments with various crops. They found borax when applied under field conditions to retard growth and crop yield. They refer repeatedly to a "bleaching" of the leaves though reduced yield was noted without chlorosis. With corn they state that badly bleached plants were obtained when borax was used in amounts greater than 5 pounds per acre. They suggest "this prevention of chlorophyll formation may be due to an interference with the assimilation of iron, similar to the action of calcium or as

observed with an excess of manganese compounds." Tip burn has also been noted by these investigators as well as by others.

Summarizing the results of these various investigations, the conclusions are that boron at concentrations in excess of one part per million is toxic and that boron is essential for the growth of green plants. No evidence is available concerning the role played by boron. Views concerning the role of boron in relation to iron and toxicity have been stated previously.

Experimental Methods

In all of the previous work on boron, higher plants have been used which normally grow on soils. In my own experiments I selected two water plants, one of the duckweeds, *Spirodela polyrhyza*, a higher plant, and the other a species of *Chlorella* a unicellular alga. The former was obtained from Dr. Albert Saeger, who maintained it under pure culture condition. The alga was originally obtained from the soil by Wann and Hopkins (11) and has been maintained under pure culture conditions.

These plants were selected because their relation to iron and manganese has been well established, and it is possible to grow these in large numbers under uniform conditions. Thus, statistically such results as might be obtained should be significant.

In the experiments with *Spirodela* the plants were grown both under pure culture conditions and under ordinary water culture methods. With *Chlorella*, however, all the experiments were made under pure culture condition. With the *Spirodela* experiments, under ordinary culture conditions, ten plants were removed from the stock culture and transferred to the beakers containing the solutions under consideration. In the pure cultures only one plant was transferred to each culture at the outset of the experiment. Attention was given to the selection of uniform plants.

The stock cultures of *Chlorella* are maintained on potato-dextrose agar, a medium excellent for the growth of the alga. In starting cultures for the experimental work the following procedure was adopted. A small mass of cells was removed from the agar slope by means of the platinum needle and added to 10 cc. of sterile distilled water. This was agitated well until thorough suspension of cells was obtained. To the culture medium was then added one cubic centimeter of the suspension by means of a sterile pipette.. The suspension used in the various experiments was made to contain approximately the same number of cells.

The cultures after inoculation were placed on a table in the laboratory in front of a window where sufficient light was available for good development. The arrangement of the cultures was changed daily in order to eliminate differences in illumination.

Counts of the number of plants formed in the cultures of *Spirodela* were made from time to time during the course of the experiments. The number of leaves was also used as an index of growth. The dry weight of *Spirodela* was determined by drying the plants in vacuum oven at 50 degrees centigrade. In the experiments under ordinary cultural conditions, half of the plants were used to determine the dry weight, while those under pure culture conditions, the total number of plants was used.

The dry weight of the alga was obtained by filtering the culture through weighed gooch crucibles and then washing the cells in distilled water. The crucibles were then dried in a vacuum oven at 50 degrees centigrade and the final weight obtained.

The water used in the preparation of the cultures was obtained from an electric still. The chemicals used were Kalbaums and these were recrystallized three times. A nearly saturated solution of the salt in hot conductivity water was made. This was filtered while hot to remove detritus. The solution was then chilled in a cold alcohol bath and the resulting crystals were collected on a buchner funnel. This process was thereafter repeated twice. The sugars used were Mercks sucrose U.S.P.X. and dextrose, Bakers's Blue Label. These were not recrystallized since they gave no test for iron.

Iron determination. Ten cubic centimeters of the solution are placed in a 50 cc. Nessler tube. To this is added 1 cc. of concentrated HCl, 1 cc. of a solution of KSO_4 (potassium persulphate) containing 5 milligrams of KSO_4 per cc., and 10 cc. of a 10-per-cent solution of KSCN (potassium sulfocynate.) Fifteen cc. of an amylic mixture containing 5 parts of amyl alcohol and 2 parts of ether is then added. This is then mixed thoroughly with a vertical motion using a glass rod with a flat end in order to allow the amylic mixture to take up all the $Fe(SCN)_3$. The mixing should not be violent, otherwise an emulsion may be formed, giving the upper layer a turbid appearance. When the two layers have separated, 5 cc. of the upper layer is removed by a pipette and placed in a colorimeter tube. Comparison with a standard is then made. The standard is prepared in exactly the same way having a known amount of iron present.

Boron analysis. The precipitation was obtained from the culture medium by centrifuging. It was washed with distilled water several

times and then dissolved with concentrated HC1. The solution was made up to 50 cc. and an aliquot part taken to be tested with Tumeric paper. The Tumeric paper was allowed to stay in the solution from 24 hours to 48 hours.

EXPERIMENTS WITH *Spirodela Polyrhyza*

The culture solution used for *Spirodela* was Knop's solution modified to the extent of obaining a balance medium which would give maximum growth without forming a precipitate. This solution will be designated as K–I.

KNO_3	1.67 g.
KH_2PO_4	1.67 g.
$MgSO_4$	0.81 g.
$Ca(NO_3)_2 4H_2O$	5.00 g.
Water	1000 cc.

The culture medium used was made up by taking 10 cc. of the above stock solution and diluting it with the addition of 990 cc. of distilled water. $MnSO_4\ 4H_2O$ was added so that the concentration of manganese would be 0.1 p.p.m. Iron was added in 0.5 p.p.m. as $FeC1_3$ unless otherwise specified.

Experiment 1.

In this experiment the plants were grown under ordinary water culture methods. Beakers of 400 cc. capacity, of pyrex glass, were used. These were covered with Petri dishes to prevent the entrance of dust. In each beaker was placed 250 cc. of the culture solution. At the outset of the experiment 10 plants were transferred from the stock culture to each culture vessel. At the beginning all cultures were in duplicate but later in the experiment the individual treatments were replicated four times. The culture solutions were changed every three or four days and observations were made at these times on the color of the plants and root conditions. Counts were made also of the number of plants per culture. The results of this experiment are summarized in Table 1 and presented graphically in Figure 1.

When the data under date of April 11 are noted it will be observed that there appears to be a marked stimulation of growth by concentrations in excess of 30 p.p.m. The large number of plants is due not to increased growth but to a breaking up of the original plant into many smaller individuals consisting usually of single leaves. This is characteristic of the duckweeds when an unfavorable

condition is present and is to be taken as evidence of toxicity. These individuals soon die so that in the figures given under April 21 no data are recorded for these cultures with the highest concentrations. Furthermore, the final figures on the number of plants do not reflect fully the differences in growth between the boron-treated plants and the controls, since the plants with boron were generally smaller. This will be referred to again subsequently.

The controls were not of a deep green color indicating that iron was in part deficient, but those plants with boron were more deficient in chlorophyll.

TABLE 1—INFLUENCE OF BORON ON GROWTH OF *SPIRODELA*. BORON ADDED AS BORIC ACID. EXPERIMENT BEGUN APRIL 7 WITH 10 PLANTS IN EACH CULTURE.

Treatment	Number of Plants per Culture			Ave. No. Plants April 21	Condition
	April 11	April 16	April 21		
Control	17	51	100		
Control	16	46	110	99	Slight
Control			94		Chlorosis
Control			92		
Boron 1 p. p. m.	12	38	50		
Boron 1 p. p. m.	12	28	54		
Boron 1 p. p. m.			54	55	Chlorotic
Boron 1 p. p. m.			60		
Boron 5 p. p. m.	10	31	24		Chlorotic and
Boron 5 p. p. m.	15	36	24	24	plants smaller
Boron 5 p. p. m.			24		
Boron 5 p. p. m.			24		
Boron 10 p. p. m.	12	30	22	22	Chlorotic and
Boron 10 p. p. m.	10	32	22		plants smaller
Boron 20 p. p. m.	10				
Boron 20 p. p. m.	11				
Boron 30 p. p. m.	13				
Boron 30 p. p. m.	16				Plants very small and very chlorotic
Boron 40 p. p. m.	22				
Boron 40 p. p. m.	30				
Boron 50 p. p. m.	33				
Boron 50 p. p. m.	34				

The chlorosis noted in the plants grown with boron began with a discoloration at the tip of the lobes spreading down to the base of the lobes. The possibility of iron being deficient in the solution and causing the chlorotic appearance was considered. Iron was added 0.125 parts per million to one culture in each series. The addition of this extra iron as $FeCl_3$ did not correct the chlorosis. The reason for this lack of response to extra iron will be presented and discussed subsequently. It was still assumed that iron was unavailable. With this point in mind 20 parts per million of potassium tartrate was added to each of the cultures in which the amount of iron had been

increased. The results of the addition of potassium tartrate were observed four days later. All the cultures to which it had been added became green and normal in color. Algal growth in the solution containing the tartrate also showed the beneficial effect of the treatment.

In summarizing these results boron was found to be detrimental to growth. Signs of its toxic action were shown by the chlorosis of the leaves, loss of roots and general decrease in size and growth. The addition of potassium tartrate induced chlorophyll formation.

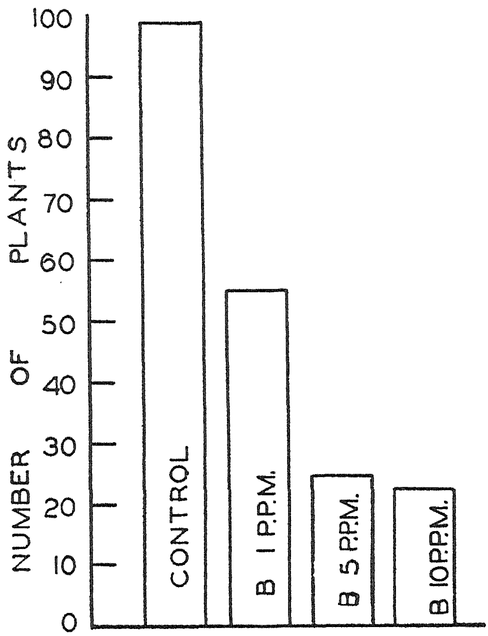

Figure 1.—Influence of boron on growth of *Spirodela polyrhyza* based on average number of plants in cultures on April 21.

Experiment 2.

In this experiment the culture conditions were essentially like those of the preceding experiment except that potassium tartrate was used in half of the cultures. The tartrate was added as a means of maintaining the availability of iron. This has been used repeatly for this purpose and in Experiment 1 proved effective in inducing chlorophyll formation. As in the previous experiment iron was added at the rate of 0.5 p. p. m. To reduce algae contamination the solutions were renewed at intervals of four to six days.

TABLE 2—EFFECT OF BORON ON *SPIRODELA POLYRHYZA*. EXPERIMENTS BEGUN ON APRIL 26. TEN PLANTS WERE INITIALLY PLACED IN EACH CULTURE. FIGURES REPRESENT AVERAGE OF FOUR CULTURES.

Treatment	No. of Plants*	May 13th		No. of Plants*	June 6th	
		Dry Wt.	Relative Dry Wt.		Dry Wt.	Relative Dry Wt.
Control	20	22.4	100	45	32.5	100
Boron 1 p. p. m	66	31.6	141	34	33.5	103
Boron 2 p. p. m	57	37.9	168	29	24.9	76.6
Boron 5 p. p. m	52	30.8	137	°47	25.1	77.0
Boron 10 p. p. m	45	5.3	23.6	Dead	...	...

° Plants small due to fragmentation.
* Plants were removed at definite intervals from each culture, the percentage removed from all flasks being the same.

After May 13th the plants in some of the cultures became too numerous and it was necessary to remove half of the plants from all cultures at this time. Those removed were used for dry weight determination. Subsequent removals of plants were made so that the plants were halved on May 19, 24, and 31. The plants were halved therefore four times. No figures are given to show the total number of plants that would have been produced if the containers had been sufficiently large with adequate volume of solution, and no reduction in the number of plants, as has been done by others.

TABLE 3—EFFECT OF BORON ON *SPIRODELA* IN THE PRESENCE OF POTASSIUM TARTRATE. EXPERIMENT BEGUN APRIL 26. TEN PLANTS WERE INITIALLY PLACED IN EACH CULTURE. FIGURES REPRESENT AVERAGE OF FOUR CULTURES.

Treatment	No. of Plants*	May 13th		No. of Plants*	June 6th	
		Dry Wt.	Relative Dry Wt.		Dry Wt.	Relative Dry Wt.
Control	37	26.4	100	83	64.2	100
Boron 1 p. p. m	51	37.2	141	52	36.8	57.4
Boron 2 p. p. m	47	39.1	148	42	32.1	50.6
Boron 5 p. p. m	°45	21.5	81.4	°70	13.4	20.8
Boron 10 p. p. m	°50	6.8	25.7	Dead	...	...

° Plants small due to fragmentation.
* Plants were removed at definite intervals from each culture, the percentage removed from all flasks being the same.

The detailed data are given in Tables 2 and 3 relative values are combined in Table 4. It should be noted that for the initial period of growth boron at concentration of from 1 p.p.m. to 5 p.p.m. actually increased the number of plants produced and the dry weights. This was true when the plants were grown without tartrate and with tartrate, though with the latter there was no stimulation of growth with 5 p. p. m. In the later periods of growth there was a marked decrease in yield with all concentrations of boron except in the cultures con-

taining 1 p. p. m. of boron without tartrate. Ten parts per million of boron were markedly toxic. In the culture without tartrate chlorosis was more pronounced than in the controls at the close of the experiment.

TABLE 4—INFLUENCE OF BORON ON *SPIRODELA* WITH AND WITHOUT TARTRATE. RELATIVE VALUES OF DRY WEIGHTS.

Treatment	May 13		June 6	
	— Tartrate	+ Tartrate	— Tratrate	+ Tartrate
Control	100	100	100	100
Boron 1 p. p. m.	141	141	103	57.4
Boron 2 p. p. m.	168	148	76.6	50.6
Boron 5 p. p. m.	137	81.4	77	20.8
Boron 10 p. p. m.	23.6	25.7	Dead	Dead

Volume of solution—250 cc.

Experiment 3.

In order to test the effect of potassium tartrate on boron toxicity under controlled conditions, experiments were started using pure culture methods. The nutrient culture solution used was the same as that of the preceding experiments. The concentration of boron ranged from 0.5 to 5.0 p. p. m. Potassium tartrate was also added to half of the cultures in concentration of 20 p. p. m. One sterile plant of *Spirodela* was transferred to each culture. The cultures were kept at room temperature near a window and were allowed to grow for five weeks. The results obtained are presented in Table 5. They are shown graphically in Figures 3 and 4.

TABLE 5—EFFECT OF BORON ON *SPIRODELA* UNDER PURE CULTURE CONDITIONS WITH AND WITHOUT TARTRATE. ONE PLANT WAS INITIALLY PLACED IN EACH CULTURE.

Treatment	With Potassium Tartrate			Without Potassium Tartrate		
	Average No. of Plants	Average Dry Weight	Relative Dry Weight	Average No. of Plants	Average Dry Weight	Relative Dry Weight
Control	53	21.7	100	33	14.7	100
Boron 0.25 p. p. m.	56	24.5	112	34	12.4	84.3
Boron 0.5 p. p. m.	49	23.9	110	38	17.2	119
Boron 1.0 p. p. m.	65	26.0	119	36	16.1	109
Boron 2.0 p. p. m.	55	20.4	94	53	18.7	127
Boron 5.0 p. p. m.	12	1.4	6.3	29	2.7	18.3

Duration of experiment—5 weeks.
Figures are averages of 3 cultures.
Volume of solution—250 cc.

Boron proved to be extremely toxic at five parts per million both with and without tartrate. With two exceptions greater growth was

obtained when boron was present at concentrations of 2 p. p. m. or less. Potassium tartrate, while it maintains iron in solution, has no influence on the toxicity of boron. No chlorosis was observed in any of these cultures.

Experiment 4.

Various investigators (27) (28) have suggested that boron toxicity may be related to deficiency of iron, and that chlorosis observed with high boron content is the result of an iron deficiency rather than to a direct action of boron. The results in my own experiments suggest a similar relationship though subsequently no chlorosis was

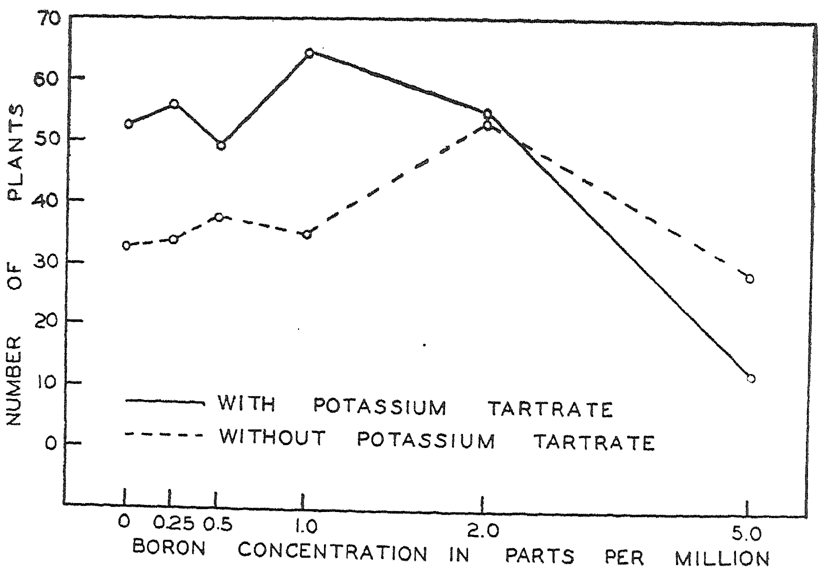

Figure 2.—Influence of boron on growth of *Spirodela*.

noted. In Experiment 4 an attempt was made limiting the higher concentrations of boron. The data are given in Table 6. There are some discrepancies in the analysis of iron in the series without tartrate and more iron remains available with tartrate than without tartrate. Nevertheless the toxic influence of boron still prevails at concentrations in excess of 2 p. p. m. and even at some of the lower concentrations.

Experiment 5.

To determine the relation of boron to iron availability with and without potassium tartrate in the absence of plants the following ex-

periment was started. The solution used was the same as that of preceding experiments. To the individual flasks containing 250 cc. of the nutrient solution boric acid was added to supply boron in the concentrations indicated in Table 7. Half of the cultures received 20 p. p. m. of potassium tartrate. The solutions were not sterilized. Hydrogen-ion and iron concentrations were determined daily for a period of seven days. The analysis made of these solutions on the day in which they were prepared showed no essential difference in the iron concentrations in the various cultures.

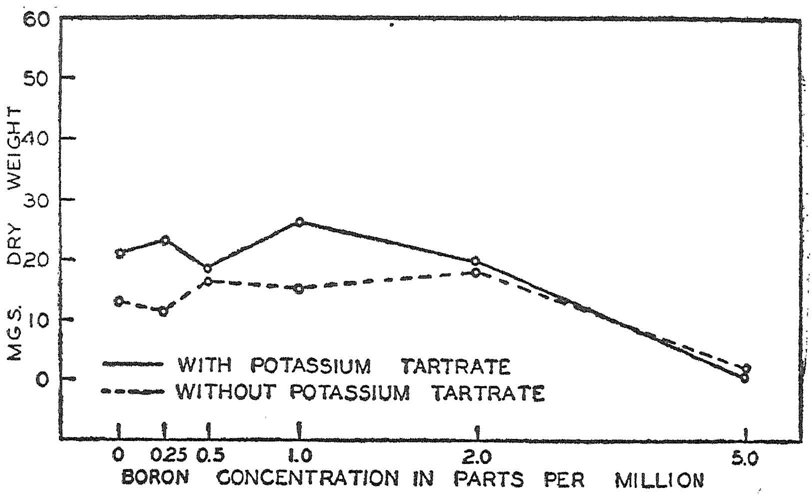

Figure 3.—Influence of boron on the dry weight of *Spirodela.*

TABLE 6—EFFECT OF BORON ON THE IRON CONCENTRATION. ONE PLANT WAS INITIALLY PLACED IN EACH CULTURE.

Treatment	With Potassium Tartrate		Without Potassium Tartrate	
	Average No. of Plants	Average Iron Conc.	Average No. of Plants	Average Iron Conc.
Control	92	0.1080 mgs.	44	0.05 mgs.
Boron 0.25 p. p. m.	102	0.0860 mgs.	47	0.022 mgs.
Boron 0.5 p. p. m.	108	....	65	0.044 mgs.
Boron 1.0 p. p. m.	86	0.1050 mgs.	55	0.050 mgs.
Boron 2.0 p. p. m.	58	0.1180 mgs.	52	0.025 mgs.
Boron 5.0 p. p. m.	22	....	30	....

Volume of solution—250 cc.
Duration of experiment—5 weeks.
Figures are average of 3 cultures.

All contained approximately about 0.125 mgs. of iron per flask. By the fourth day the available iron content of the tartrate series, which is shown in Table 7, was in excess of those without tartrate. Boron had no effect on the solubility of iron under these conditions. A flocculent and amorphous precipitate was present in the cultures the third day after they were prepared. This was evidently the reason for a decrease in the iron content.

TABLE 7—EFFECT OF BORON ON THE SOLUBILITY OF IRON ANALYSIS MADE 4 DAYS AFTER PREPARATION OF THE SOLUTION. AMOUNTS GIVEN ARE FOR 250 cc. OF THE CULTURE SOLUTION.

Treatment	Without Potassium Tartrate		With Potassium Tartrate	
	pH	Iron Conc. Mgs.	pH	Iron Conc. Mgs.
Control	5.16	0.022	6.7	0.025
Boron 0.25 p. p. m.	5.14	0.020	6.5	0.032
Boron 0.5 p. p. m.	4.9	0.020	6.6	0.032
Boron 1.0 p. p. m.	4.9	0.025	5.8	0.062
Boron 2.0 p. p. m.	4.9	0.022	5.8	0.050
Boron 3.0 p. p. m.	4.9	0.017	5.9	0.050

Figures are average of four cultures.

EXPERIMENTS WITH CHLORELLA SP.

The nutrient solution used in these experiments was a modified Knop solution, having the following composition:

KNO_3	0.1 g.
KH_2PO_4	0.1 g.
$MgSO_4 7H_2O$	0.1 g.
$Ca(NO_3)_2 4H_2O$	0.3 g.
Water	600 cc.

This solution was diluted by using 100 cc. of the above solution and 900 cc. of distilled water. $MnSO_4$ $4H_2O$ was added so that the concentration of manganese was 0.1 p. p. m. Iron was added in five tenths (0.5) p. p. m. as $FeCl_3$ unless otherwise specified:

Chlorella was chosen for these experiments because the relation of this plant to iron had been studied carefully by Hopkins and Wann (11) and later Hopkins (13). Since it has been assumed by Sideris and Krauss (27) and Skinner, Brown and Reid (28) that boron toxicity may be related to the availability of iron, it seemed appropriate to select the iron relations which are so well established. The relation of iron to chlorophyll formation in *Chlorella* has been investigated by Emerson (7). Furthermore there is some advantage

in using unicellular plant since complications due to internal precipitation of iron in the nodes are avoided.

Experiment 6.

In order to determine the tolerance of *Chlorella* to boron, an experiment was made using solution K–2 to which boron was added in varying amounts. Potassium tartrate was added to half of these cultures at a concentration of 20 p. p. m. The tartrate was added as in previous experiments to increase the availability of iron. The results obtained are presented in Table 8 and in Figure 4. With the tartrate present there appears to be a slight stimulation of growth with boron at a concentration of 1 to 20 p. p. m. inclusive. Less growth was noted at 30 p. p. m. Without tartate, stimulation was noted in cultures containing boron at 5 and 10 p. p. m. The reduction in yield at 30 p. p. m. was more pronounced in the cultures without tartrate than with tartrate.

Experiment 7.

The experiment was similar to the preceding except that sodium citrate at 20 p. p. m. was used instead of tartrate. The concentrations of boron was used in the range previously found to be stimulatory. The detailed data are given in Table 9. Marked stimulation of growth was noted in all the cultures containing boron. This was true whether citrate was used or not.

Experiment 8.

To obtain evidence on the possible action of boron in reducing iron toxicity, an experiment was started in which the iron concentration was varied from 0.5 to 10 p. p. m. Boron was kept constant at 20 p. p. m. Solution K–2 under pure culture methods was used. The initial and final ph of the various culture solutions were determined. This together with the dry weight of the cultures is presented in Table 10. When the solution was prepared it was noted that iron precipitation increased with an increase in iron concentration. During the first 20 days it was noted that growth was very slow in the cultures containing above 4 p. p. m. of iron. Afterwards growth became faster and at the end of 43 days the culture with 8 p. p. m. had almost attained the same amount of growth as those with 4 and 6 p. p. m. Had the experiment been concluded earlier more marked differences would have been noted in the yield between the lower and the higher iron concentrations. The results do not show any effect of boron on reducing iron toxicity since there is not a marked difference between the cultures with and without boron.

TABLE 8—INFLUENCE OF BORON ON THE GROWTH OF *CHLORELLA* IN THE PRESENCE OF POTASSIUM TARTRATE.

Treatment	With Potassium Tartrate	Without Potassium Tartrate
	Dry Weight Mgs.	Dry Weight Mgs.
Control	31.9	23.7
Boron 0.5 p. p. m	30.8	22.5
Boron 1.0 p. p. m	33.6	20.9
Boron 2.0 p. p. m	36.6	23.5
Boron 5.0 p. p. m	34.7	26.8
Boron 10 p. p. m	34.7	27.0
Boron 20 p. p. m	34.1	22.3
Boron 30 p. p. m	20.2	16.6

Figures are averages of six cultures.
Age of the cultures—40 days.
Volume of solution—250 cc.

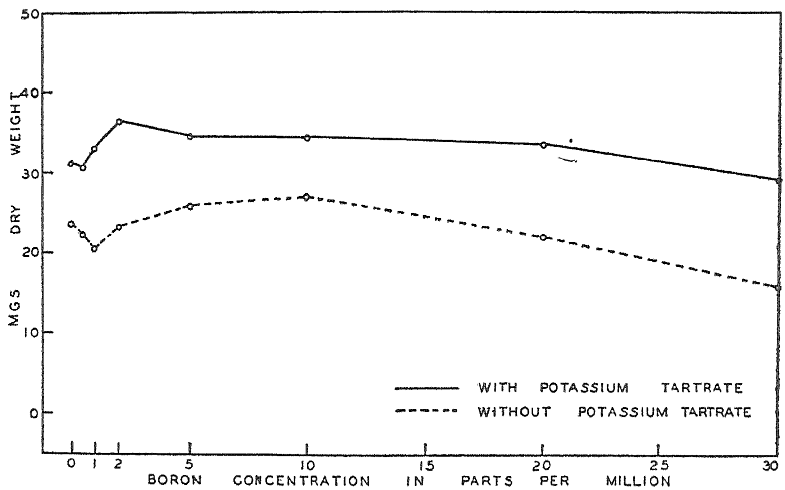

Figure 4.—Effect of boron on growth of *Chlorella*.

TABLE 9—INFLUENCE OF BORON ON THE GROWTH OF *CHLORELLA* IN THE PRESENCE OF SODIUM CITRATE.

Treatment	With Sodium Citrate	Without Sodium Citrate
	Dry Weight Mgs.	Dry Weight Mgs.
Control	7.0	2.8
Boron 0.25 p. p. m	12.0	2.9
Boron 0.5 p. p. m	12.0	3.6
Boron 1.0 p. p. m	12.8	3.8
Boron 2.0 p. p. m	12.1	5.3
Boron 5.0 p. p. m	14.9	6.7
Boron 10.0 p. p. m	18.5	5.7

The figures are averages of six cultures.
Age of the cultures—22 days.
Volume of solution—250 cc.

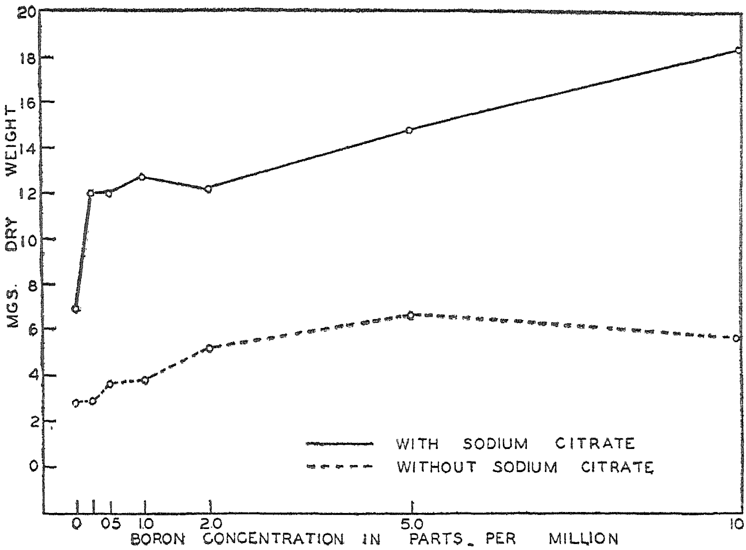

Figure 5.—Effect of boron on growth of *Chlorella*.

Experiment 9.

In the previous experiments with *Chlorella* little or no toxicity of boron was noted. Consequently in this experiment concentrations of boron up to 140 p. p. m. were used. The experiment was similar to experiments 7 and 8 except that the cultures were kept under a cheesecloth shade in the greenhouse, with temperatures prevailing from 20 degrees to 25 degrees C. Because of slow growth under these conditions the cultures were brought back to the laboratory after ten days where a higher degree of illumination was used. All the cultures were repeated six times and the figures given in Table 11 are the average of the six cultures.

TABLE 10—EFFECT OF INCREASING IRON CONCENTRATIONS ON THE GROWTH OF *CHLORELLA* IN THE PRESENCE OF BORON.

Treatment	Iron Conc.	Initial pH	Dry Weight Mgs.	Final pH
	p. p. m.			
Full Nutrient	0.5	4.38	27.4	6.67
F. N.—Boron	0.5	4.38	26.7	6.92
Full Nutrient	2.0	4.12	28.6	6.70
F. N.—Boron	2.0	4.12	28.9	6.67
Full Nutrient	4.0	3.78	27.9	6.67
F. N.—Boron	4.0	3.78	29.8	6.67
Full Nutrient	6.0	3.61	23.9	7.01
F. N.—Boron	6.0	3.61	26.8	7.01
Full Nutrient	8.0	3.44	21.8	6.58
F. N.—Boron	8.0	3.44	20.8	6.41
Full Nutrient	10.0	3.44	18.2	5.14
F. N.—Boron	10.0	3.44	20.0	5.82

Boron—20 p. p. m. as boric acid.
Iron as $FeCl^3$.
Age of cultures—43 days.
Figures are averages of 4 cultures.
Volume of solution—250 cc.

The results show that with and without sodium citrate growth is decreased at all concentrations of boron as compared to the controls, but even at the highest concentration *Chlorella* was still alive at the end of 23 days and had made appreciable growth. A better growth was obtained with sodium citrate than without and this is probably related to a greater availability of iron as is indicated in the iron concentration of culture solutions not seeded with *Chlorellæ.*

Experiment 10.

This experiment was essentially the same as the one previously described, except that dextrose was supplied to each culture at a concentration of 1%. The sugar was used merely to permit a more luxuriant growth and to know if under these conditions the toxicity of boron still prevails. At the conclusion of the experiment all of the cultures with sugar showed a distinctive chlorosis. The cultures instead of being deep green were of an orange color. This appeared first in the cultures containing boron but within a day or so the same condition was noted for the control. Dr. E. F. Hopkins of this laboratory suggested that the chlorosis observed was probably due to a lack of nitrogen. With the yield on a dry weight basis obtained and with the values reported by Muenscher (24) for the nitrogen requirement of *Chlorella* grown under similar conditions, it was possible to calculate the nitrogen content of *Chlorella* of my experiments. These data taken with the nitrogen content of the culture solutions sustained the conclusion that nitrogen was deficient. Nevertheless during the progress of the experiment no differences were noted between those cultures with boron and those without boron. Apparently sugar reduced markedly the toxicity of boron and a very considerable growth was obtained at a concentration of 140 p. p. m. This may be a matter of great significance.

Experiment 11.

In another experiment similar to the preceding one sucrose at a concentration of 1% was used. Here again no toxicity was obtained even with 80 p. p. m. In fact a greater growth was obtained with the higher concentration of boron. This was due probably to a greater inversion of sucrose at these higher concentrations. While no conclusions concerning the effect of the various concentrations of boron can be drawn from this experiment, the significant fact is presented that in the presence of sucrose boron had no toxic effect on *chlorella.*

TABLE 11—EFFECT OF BORON ON THE GROWTH OF *CHLORELLA* SP. AND ON THE AVAILABILITY OF IRON.

Treatment	Boron Concentration p. p. m.	Dry Weight in Mgs.	Iron Concentration in Mgs.	Iron Concentration in Non-seeded Cultures Mgs.
Full Nutrient		3.8	0.006	0.008
F. N. Boron	10	2.2	0.006	0.008
	20	2.0	0.006	0.009
	40	1.9	0.009	0.010
	60	1.8	0.010	0.010
	80	2.1	0.007	0.009
	100	1.6	0.009	0.010
	120	1.2	0.008	0.010
	140	1.1	0.007	0.010
F. N. Na-citrate		7.4	0.007	0.014
F. N. Boron and Na-Citrate	10	6.8	0.008	0.011
	20	5.2	0.010	0.018
	40	3.9	0.010	0.016
	60	3.2	0.010	0.020
	80	2.5	0.010	0.017
	100	1.8	0.008	0.020
	120	1.5	0.008	0.018
	140	1.5	0.010	0.017

Duration of experiment—22 days.
Volume of solution—50 cc.

TABLE 12—EFFECT OF BORON ON THE GROWTH OF *CHLORELLA* SP. AND ON THE AVAILABILITY OF IRON IN THE PRESENCE OF SUGAR AND SODIUM CITRATE.

Treatment	Boron Concentration p. p. m.	Dry Weight in Mgs.	Iron Concentration in Mgs.	Iron Concentration in Non-seeded Cultures Mgs.
F. N. Dextrose		37.0	0.009	0.015
F. N. Boron and Dextrose	10	34.5	0.008	0.020
	20	34.8	0.009	0.021
	40	34.2	0.008	0.022
	60	34.2	0.009	0.018
	80	34.5	0.009	0.017
	100	34.4	0.005	0.020
	120	31.4	0.006	0.018
	140	28.0	0.007	0.017
F. N. Dextrose Na-c		31.0	0.014	0.024
F. N. Boron Sodium Citrate and Dextrose	10	36.2	0.013	0.020
	20	36.9	0.016	0.024
	40	39.4	0.010	0.023
	60	39.4	0.011	0.021
	80	39.0	0.014	0.024
	100	37.1	0.009	0.022
	120	35.4	0.010	0.022
	140	33.9	0.009	0.021

Duration of experiment—22 days.
Volume of solution (50 cc.)

TABLE 13—INFLUENCE OF BORON ON THE GROWTH OF *CHLORELLA* IN THE PRESENCE OF SUCROSE.

Boron Concentration	Initial pH	Final pH	Dry Weight Mgs.
20	4.3	5.58	27.6
40	4.3	6.84	29.7
60	4.3	6.53	38.9
80	4.3	6.37	43.7

Duration of experiment—30 days.
Volume of solution—50 cc.

Discussion

Several hypotheses have been offered by various investigators to explain the cause of chlorosis obtained when boron is present in the culture medium. Haas (8) in his studies on the toxic effect of boron on fruit trees reported an experiment in which lemon seedlings were grown in water cultures. Hoaglands solution plus 7.5 p. p. m. of boron and varying amounts of iron sulphate ranging from 5 to 105 p. p. m. was used. Photographic evidence of this experiment shows that increasing iron from 5 to 25 p. p. m. counteracted the apparent toxic symptoms of boron. Haas explains these results on the basis of a catalytic action of iron or a possible precipitation of boron as an insoluble ferric borate and thus a decrease in boron concentration. Sideris and Krauss (27) obtained chlorosis in the presence of boron only when the iron content was low. They suggested that the chlorosis was due to a lack of iron caused by the formation of an insoluble ferric borate. In explaining the stimulation obtained, when boron was present, they offer the possibility that iron may have been toxic. The formation of an insoluble ferric borate would decrease the iron concentration and therefore reduce the toxic effects. Furthermore, if boron were present in an amount sufficient to cause a toxic condition the addition of more iron would decrease the soluble boron content in the same manner. Skinner, Brown and Reid (28) in their studies on the effect of borax on plants under field conditions referred repeatedly to a "Bleaching" of the leaves, though reduced yield was noticed without chlorosis. They suggested "this prevention of chlorophyll formation may be due to interference with the assimilation of iron, similar to the action of calcium or as observed with an excess of manganese compounds." This implies an effect on the permeability of the cell by boron or accumulation.

In the work of Haas, Sideris and Krauss, and Skinner, Brown and Reid lemon seedlings, pineapple and corn plants were used respectively. In these plants the leaves are relatively far removed from the absorbing zone and it is possible that the chlorosis reported

by these individuals may have been due to a relation between boron and iron. It is conceivable that boron might cause a precipitation of iron within the roots or stems and a shortage of iron would prevail in the leaves. Hence chlorosis would follow. A simple experiment of painting the leaves with a dilute iron salt possibly would have given evidence for the validity of this hypothesis.

In my own experiments a unicellular alga *Chlorella* was used in one series and the simple higher plant *Spirodela polyrhyza* in the other series. By using these plants the precipitation between the absorbing zone and the chlorophyllous region is minimized. This may account for the failure of marked chlorosis in my experiments. In the initial experiments with *Spirodela* slight chlorosis was observed in the presence of boron. This chlorosis disappeared with the addition of potassium tartrate. The controls lacking boron were also slightly chlorotic but less so than those with boron. The control plants also became greener with the addition of potassium tartrate. These data tend to confirm the viewpoint that there is a relation between boron toxicity and iron. Unfortunately the evidence in this case was not decisive.

In later experiments with *Spirodela* under pure cultures no chlorosis was induced by boron. Similarly *Chlorella* failed to show chlorosis with high boron content. Chlorosis therefore is not necessarily a characteristic of boron injury. Reduced growth as noted by Skinner, Brown and Reid may result without chlorosis and my own results confirmed these conclusions. It is true that iron deficiency may result in decreased yield without chlorosis,* so that these results are not entirely contradictory to the view exposed by Haas, Sideris and Krauss and others.

Analysis of iron showed no decrease of available iron in the culture solution used when boron is added. While a precipitate forms in the solution used and forms gradually, no boron was noted in the precipitate. The addition of potassium tartrate and of sodium citrate which increases the availability of iron while increasing growth did not reduce the toxicity of boron. The controls without boron were improved by the addition of tartrate or citrate, but comparing the boron cultures with these controls, they showed in general the usual increase or decrease of growth noted in those cultures without tartrate or citrate.

The results with sugar are suggestive. While further experiments of this character are necessary the results indicate that a plant with a high sugar content is more tolerant to boron than one with low

* Miller, E. D. Plant Physiology. p. 262. McGraw-Hill Book Co. (1931)

sugar content. It is true that the nutrient medium containing sugar has a higher content of iron, but in view of the experiments with citrate and tartrate it seems more appropiate to assign the protective action to the sugar rather than to the iron.

ACKNOWLEDGMENTS

The writer wishes to express his gratitude to Dr. Lewis Knudson for his guidance, criticisms and helpful suggestions so freely given throughout the course of this work. Acknowledgment is also due to Dr. E. F. Hopkins for his suggestions and assistance.

SUMMARY

1. Under the usual water-culture methods boron proved toxic to *Spirodela polyrhyza* at concentrations of above 1 p.p.m. Toxicity was evident in reduced growth, smaller plants, and loss of roots. In concentrations above 5 p. p. m. death soon occurred. Chlorosis was noted in all the cultures but those plants with boron were slightly more chlorotic than the controls. In both cases the addition of inorganic iron was without effect, but the addition of potassium tartrate at a concentration of 20 p. p. m. resulted in a marked chlorophyll development in all the cultures.
2. Under pure culture conditions boron seemed to increase growth at certain concentrations. At a concentration of 5 p. p. m. toxicity was apparent. No chlorosis was noted with boron.
3. With *Chlorella* under pure culture conditions marked stimulation was noted in experiments 6 and 7 with concentrations up to 10 p. p. m. and even with higher concentrations. In experiments 8, 9 and 10 no stimulation was noted.
4. *Chlorella* proved extremely resistant to boron. A concentration of 30 p. p. m. was required to decrease growth on experiment 6 while in experiment 9 toxicity was noted at a concentration of 10 p. p. m. as evidenced by decreased growth, but survived at a concentration of 140 p. p. m. No chlorosis was noted in any case.
5. The addition of sodium citrate or potassium tartrate, both of which tend to increase iron availability did not decrease the toxicity of boron when growth was taken as the criterion.
6. The addition of dextrose to the culture medium increased growth as expected and made *Chlorella* much more resistant to boron. This was likewise true of sucrose.
7. Boron did not decrease the availability of iron.
8. Boron was not found present in the precipitation formed in the culture medium. The method of analysis used was not very sensitive.

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STUDIES ON DISEASE RESISTANCE

I. A TOBACCO RESISTANT TO ORDINARY TOBACCO MOSAIC.*

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Introduction

The field of immunity and resistance to pathogens in plants is one of unusual interest and of great promise. In plants, unlike animals, efforts directed to the induction of acquired immunity have been unsuccessful, except perhaps in the case of the ring-spot of tobacco: Price (**22**) and the aucuba mosaic of tomato on *Nicotiana sylvestris:* Kunkel (**18**). In the former the virus is present in the tissues which fail to produce necrotic lesions upon a second inoculation and this peculiar reaction is systemic; in the latter immunity against the aucuba mosaic virus results from infection with the ordinary tobacco-mosaic virus and such immunity is restricted to the areas invaded by the latter.

It seems quite improbable that pathologists will find in this phase of immunity a practical answer to the problems of plant disease control. Natural inherent immunity should be a logical way of protecting the higher plants from their pathogens. Strains of some of our important crop plants exhibiting a high degree of tolerance or resistance to disease have been discovered in various regions of the world and these plants have been the basis for researches on the nature of disease resistance and on the development of new varieties of crop plants resistant to one or more diseases.

Last year the writer and Roque (**21**) announced the discovery of the mosaic resistance of the Colombian *Ambalema* tobacco (*Nicotiana tabacum* L.); but no account was given of the details of the experiments.

The purpose of this paper is to present the results and observations on infection studies with this variety of tobacco.

The investigation was begun in Puerto Rico in 1929–30 and continued at the University of Cornell (1930–1932) and the University of Winsconsin (1932–1933).

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** John Simon Guggenheim Memorial Foundation Fellow. Latin American Exchange. July 1932–Sept. 1933.

MATERIALS AND METHODS

The resistant variety *Ambalema* was the basis of all the studies; but Turkish Tobacco, var. Samsun, "*Ceniza*", "Consolation" and Connecticut Havana No. 38 were used as checks. The variety Samsun was used as one of the parents of the cross with the resistant tobacco. This variety has been in our collection since 1928 and was obtained through the courtesy of Mr. John Steele of the Puerto Rican Leaf Tobacco Co. of San Juan, who had received it from Greece. The variety Havana No. 38 was obtained from Professor James Johnson of the University of Wisconsin. The yellow tobacco "Consolation", like the *glaucous* ("Ceniza") variety, originated in Puerto Rico probably by mutation from one of the ordinary filler types. The *Nicotiana glutinosa* L. employed in this investigation was obtained from Professor Johnson.

The tobacco plants used for purposes of determining susceptibility or resistance to mosaic were grown in three or four-inch pots, in fertile soil compost.

The tobacco plants were first inoculated when very small, at about the stage of development described by Johnson (10); namely, "with only two to four leaves large enough to be inoculated." Some of the resistant plants were removed to slightly colder greenhouses after notes were taken on the results of a second inoculation. All plants regarded as resistant were inoculated three times at intervals of 7–10 days.

The *N. glutinosa* plants were similarly grown in warm greenhouses. These were planted in four-inch pots and topped down to eight or nine leaves. Topping favors expansion of the leaves. When inoculated each plant supported at least six good sized, sound leaves.

The rubbing or wiping method described by Holmes (8) was employed in all inoculations on tobacco or *N. glutinosa*. Leaf material was crushed in sterile mortars in the customary way.

The presence of the virus in a resistant plant or its concentration therein was determined by rubbing the freshly extracted juices on *N. glutinosa* or on small tobacco plants. The production of the typical symptoms of ordinary tobacco mosaic on young tobacco plants or the production of lesions on *N. glutinosa* were considered as evidence of the presence of the virus in the resistant plant.

The concentration of the virus particles in infected plants has been generally determined, on the basis of Holmes' method, by making counts of the local lesions produced on *N. glutinosa* leaves, taking as a measure the number of lesions per leaf. It occurred to the writer

that since the higher or lower rate of growth of the *N. glutinosa* plant may determine a larger or smaller number of lesions per leaf, the results obtained in different laboratories would hardly be comparable. Holmes' method presupposes unit areas but does not take care of the factor of differential rate of growth. Consequently, the number of local lesions produced per measured unit area on *N. glutinosa* was taken in this investigation as the measure of the concentration of the virus. Five leaves of *N. glutinosa* were employed for each observation. The area was measured on the third day after inoculation, when counts of lesions were made, and the number of local lesions per every 10 sq. cm. of leaf surface was taken as an index of the virus concentration. In measuring the area of leaves the following procedure was observed throughout. The leaves were outlined on a book so that a permanent record was obtained. The area was then measured from the paper with the aid of a planimeter.

The virus cultures employed in this investigation were obtained as follows: the ordinary tobacco-mosaic virus (*tobacco* virus 1) as used by Grant (7) in his studies of the suscept range of the tobacco-mosaic virus; the viruses of yellow tobacco mosaic, cucumber mosaic, yellow cucumber mosaic, potato ring-spot, Wingard's tobacco ring-spot, celery mosaic, veinbanding, and mottle were obtained from Professor Johnson's Laboratory. In the early stages of these studies we used a culture of the tobacco-mosaic virus isolated from diseased material from Puerto Rico.

The thermal inactivation point of the viruses was determined in 5 c.c. samples of freshly extracted juices by subjecting them to the desired temperatures for ten minutes, as described by Johnson (12). In the statistical study of the significance of results, Student's method for paired results and Bessel's method were employed throughout. In general, odds lower than 31.36 to 1 were considered as meaning that the deviations observed might be considered as being caused by chance alone.

Experimental Results

Infection of the resistant variety.—As a general rule, when large plants of the Colombian variety *Ambalema* are inoculated with the virus of the ordinary tobacco mosaic no appreciable visible symptoms appear on leaves or on the suckers of the inoculated plants. If such plants are examined when in a rapidly growing condition, a very mild mottling may be observed in the younger leaves of some individuals. At the beginning, plants older than six or seven weeks

were employed and, therefore, considerable doubt arose as to whether infection with the mosaic virus had taken place. Roque (23) has stated that no infection occurred in 686 inoculations that he made. The writer is satisfied that those observations were on large plants on which the symptoms must not have been evident. In the present trials plants of all ages were inoculated with the virus and it has been found that infection occurred in every instance irrespective of size of plant.

On small plants.—The first experiment to determine the production of visible symptoms of ordinary tobacco mosaic on small plants of the resistant strain, consisted of the inoculation of ten plants. Five plants each of "Ceniza", "Consolation", Turkish and Havana No. 38 were used as checks. At the end of two weeks the typical symptoms of the disease were very evident on all the checks. On the resistant variety clearing of the veins occurred and was followed by interveinal small chlorotic areas of a mild type, which appeared by the ninth day and became more evident at the end of two weeks. (See figs. 1–7 and 10–14.) These plants and checks of the Turkish variety were transferred to six-inch pots and finally to ten-inch pots and kept until blossoming time. Soon after transferring to the large pots the symptoms disappeared from the resistant plants and these reached normal development. The check plants remained stunted and numerous lesions were evident on the older leaves. During the course of this investigation a total of 373 small plants of the *Ambalema* variety and adequate checks were inoculated and studied. It is concluded from the experiment that young plants of the *Ambalema* variety become infected with the ordinary tobacco-mosaic virus as shown by symptoms and presence of the virus in the tissues but that infected plants apparently recover from the disease as is indicated by subsequent normal growth and disappearance of symptoms.

On large plants.—Plants 4, 6 and 8 weeks old were inoculated in order to determine susceptibility to infection. Clearing of veins was noted at the end of five to seven days on the 4-week old plants, but it soon disappeared. (See figs. 8 and 9.) No visible symptoms were noted on the older plants. In order to determine if these plants had become infected the juice from the inoculated leaf and the three successive leaves was extracted separately and *N. glutinosa* and check plants inoculated with it. Necrotic local lesions appeared on *N. glutinosa* and typical symptoms developed on the check susceptible tobacco plants indicating the presence of the mosaic virus in the tissues of the inoculated plants.

On transplants.—An experiment was made with the purpose of ascertaining whether infection occurs in plants of the age at which they are ordinarily transplanted into the field. Four-week-old seedlings were pulled and treated as follows: (*a*) 100 *Ambalema* and 25 susceptible seedlings inoculated with the mosaic virus; (*b*) 25 *Ambalema* and 25 susceptible seedlings left uninoculated. All were transplanted into 4-inch pots. At the end of 7–10 days mild symptoms were discovered on the inoculated *Ambalema* plants, severe symptoms on young leaves of susceptible plants, and no change on the uninoculated *Ambalema* and susceptible plants. At the end of four weeks, only the lower leaves of inoculated *Ambalema* plants showed a very faint mottling; the inoculated susceptible plants were severely affected with mosaic and were discarded. All the inoculated *Ambalema* plants and ten each of uninoculated *Ambalema* and susceptible plants were planted in the garden and observations made until blossoming had occurred. The extracted juices from the inoculated plants when inoculated to *N. glutinosa* plants showed the presence of the virus in those plants. Judging from type and rapidity of growth, the inoculated *Ambalema* plants made as normal a development as the uninoculated *Ambalema* plants. The susceptible uninoculated plants became infected after transplanting in the garden. The experiment proves that in the case of the resistant tobacco, even though infection occurs during transplanting, the plants will not be seriously affected and will recover from the disease although the virus may be present in the tissues.

Reaction of the Ambalema tobacco to other viruses.—It was deemed of considerable interest to determine the reaction of this tobacco to other viruses known to infect ordinary tobacco. This variety of tobacco would have been of unique value if it had turned out to be resistant to these viruses. Lots of ten plants were each inoculated with the virus of the following diseases: cucumber mosaic, yellow cucumber mosaic, potato ring-spot (healthy potato virus) Wingard's tobacco ring-spot, veinbanding, mottle (healthy potato virus), veinbanding plus potato ring-spot (spot necrosis), celery mosaic, yellow tobacco mosaic, and the ordinary tobacco mosaic as a check. The results were as follows:

(*a*) The cucumber and the yellow cucumber mosaic viruses infected the plants very virulently producing much malformation and a very conspicuous pattern on the leaves. (See figs. 17, 18, 20 and 22.)

(*b*) *Potato ring-spot.* The ring-spot virus obtained from apparently healthy potatoes and proved by Johnson (**10**) to cause a peculiar ring-spot disease on tobacco, can infect the *Ambalema* tobacco and produce the typical symptoms on the leaves. Infected plants did not recover under the conditions of the warm greenhouse; the plants became stunted and were finally destroyed.

(*c*) *Tobacco ring-spot.*—The virus of the ring-spot of tobacco, reported by Fromme, Wingard, and Priode (**5**) as an infectious disease, produces a very virulent infection on the *Ambalema* tobacco. The symptoms appear on the third day after inoculation and infection becomes readily systemic in the plants. Severe defoliation ensues and attempts of infected plants at new vegetative growth are quickly frustrated by the necrotic ring spots which extend over the blades of open or unfolding leaves. The infection is much more severe than that produced by the potato ring-spot virus. Plants do not recover from infection. (See fig. 16.)

(*d*) *Mottle.*—The virus obtained from healthy potatoes and producing a mottling in tobacco (Johnson: **10**) unlike that induced by the ordinary tobacco-mosaic virus, was found to infect the *Ambalema* variety. The symptoms were similar to those observed on the check Havana No. 38 plants. The plants seemed to be little affected by the disease even though the characteristic symptoms appeared successively in the new growth.

(*e*) *Veinbanding.*—The veinbanding virus, one of the factors responsible for the rugose mosaic of the potato, when inoculated into *Ambalema* plants produces symptoms similar to those produced by the same virus on other tobacco plants. In our experiments, the clearing of the veins while not as striking as that produced by infection of the check Havana No. 38 plants, did not fade away, as in the case of the clearing of the veins which results consequent to infection with the ordinary tobacco mosaic.

(*f*) *Spot-necrosis.*—This disease of tobacco, first described by Johnson (**10**) and suggested by him (**13**) as identical with the rugose mosaic of potato was definitely established by Koch (**16, 17**) to be a combination of the mottle obtained from apparently healthy potatoes and the insect-transmitted veinbanding. Koch (**17**) further demonstrated that the spot- necrosis could be produced by a combination of the potato ring-spot virus and the veinbanding virus. This combination was inoculated into the *Ambalema* plants. Infection oc-

curred and on the third day necrosis of the leaf tissue was well under way. Within a week, most of the leaves had been involved. The plants were transplanted into large pots and removed to a slightly colder greenhouse. Leaves showed necrotic lesions while still unfolded, and the plants finally succumbed to infection. It can be stated without hesitation that the severest infection was produced by this combination of viruses.

(*g*) *Celery mosaic.*—The virus causing a mosaic in celery and described by Wellman (**26**) as *celery virus* 1, produced symptoms on *Ambalema* which are somewhat similar to those produced on Havana No. 38 tobacco plants. The plants, however, seem to be able to grow to maturity even though somewhat stunted.

(*h*) *The yellow tobacco-mosaic virus* produced infection on *Ambalema* plants and visible symptoms were evident by the sixth day after inoculation. These appeared in the form of small yellow areas which in many instances were bordered by a lesion-like zone (See fig. 15). The yellow areas seemed to be more conspicuous and frequent along and near the margin of the leaves. The infected plants were evidently more seriously affected than similar plants inoculated with the ordinary tobacco-mosaic virus. This point may be of interest since the difference between the yellow tobacco-mosaic virus and that causing ordinary tobacco mosaic have not been clearly defined. The affected plants were able to attain full development even though exhibiting the small mosaiced areas.

Degree of Resistance

It has been stated above that infection in the resistant variety occurs whenever plants are properly inoculated, that the symptoms appear only mildly in small plants and that recovery seems to develop with age. In order to determine in a fairly quantitative way the degree of resistance of the resistant plants, a comparison was made on the basis of the virus concentration in *Ambalema* and susceptible (Havana No. 38) plants of different sizes and ages as indicated by the number of local lesions produced on *Nicotiana glutinosa.* The concentrated juice extract from the leaves of plants of corresponding age was employed in the tests. The results appear in tables I, II and III. In every case the number of lesions in the tables corresponds to a different plant. The significance of the differences is determined by Student's method.

TABLE I.—CONCENTRATION OF THE VIRUS IN THE JUICE OF *AMBALEMA* & HAVANA No. 38 PLANTS, FIVE WEEKS OLD: JUICE EXTRACTED ONE WEEK AFTER INOCULATION; LESIONS PER 10 SQ. CM. OF *N. GLUTINOSA* LEAF SURFACE.

Ambalema	Havana No. 38	d^2	M	S. D.
14.326	90.324	3.119		
20.621	91.258	12.921		
24.287	86.326	148.669		
26.920	97.216	528.264		
18.445	83.717	80.282		
Total		773.258	74.232	12.4359

The value of Z was found to be 5.97. The odds were determined from the table on the values of Z. With this number of observations and Z taken as 6.0, the odds were found to be higher than 9999 : 1 against a difference as great as 74.232 occurring due to chance alone. Therefore this experiment shows a difference in resistance between *Ambalema* and Havana No. 38 at an age of five weeks.

TABLE II—CONCENTRATION OF THE VIRUS IN THE JUICE OF *AMBALEMA* AND HAVANA No. 38 PLANTS, 9 WEEKS OLD; JUICE EXTRACTED FOUR WEEKS AFTER INOCULATION; LESIONS PER 10 SQ. CM. OF *N. GLUTINOSA* LEAF SURFACE

Ambalema	Havana No. 38	d^2	M	S. D.
2.678	35.083	108.556		
14.241	86.766	882.149		
17.077	68.909	291.624		
17.953	91.461	63.250		
17.139	67.767	60.902		
19.499	55.925	40.934		
21.128	38.161	665.176		
25.961	56.553	149.622		
26.660	49.441	401.722		
17.257	57.769	5.345		
Total		2,669 280	42.824	16.3379

The value of Z was found to equal 2.6 which for this number of observations shows odds higher than 9999 : 1, indicating that the difference 42.824 is not due to chance alone. *Ambalema* plants at an age of nine weeks are more resistant than equally old Havana No. 38 plants.

TABLE III—CONCENTRATION OF THE VIRUS IN THE JUICE OF *AMBALEMA* AND HAVANA No. 38 PLANTS, 13 WEEKS OLD; JUICE EXTRACTED NINE WEEKS AFTER INOCULATION; LESIONS PER 10 SQ. CM. OF *N. GLUTINOSA* LEAF SURFACE.

Amablema	Havana No. 38	d^2	M	S. D.
10.237	42.017	37.577		
4.215	37.401	22.313		
3.328	47.610	40.602		
4.493	46.771	19.079		
4.327	36.762	29.976		
10.909	24.892	572.501		
1.609	27.671	140.375		
5.033	30.502	154.778		
5.103	28.877	199.826		
7.150	30.632	208.167		
5.016	54.642	137.265		
0.159	49.770	136.913		
0.324	55.007	281.334		
1.874	46,666	47.362		
1.080	52.113	172.213		
2.751	52.823	147.914		
8.476	55.598	84.861		
6.343	47.102	8.117		
5.247	51.316	66.569		
2.402	30.114	103.999		
Total		2,611.744	37.910	11 4275

The value of Z is 3.317, which with n = 20, gives odds higher than 9999 : 1 that the difference is not due to chance alone. Therefore, it may be concluded that the lower concentration of the virus in the resistant plant may be considered as meaning that a quantitative difference in resistance exists between the *Ambalema* and the Havana No. 38 tobacco plants of thirteen weeks of age.

The results given above seem to show that a difference in resistance to ordinary tobacco mosaic exists between the *Ambalema* and the Havana No. 38 tobacco varieties, as measured by the number of local lesions produced on *N. glutinosa* leaves by the extracted juice of inoculated plants of corresponding age and size. This difference in resistance is expressed in terms of lesions per ten square centimeters of leaf surface of *N. glutinosa*.

Using Bessel's method for the determination of the probable error the difference in concentration of the ordinary tobacco-mosaic virus in the *Ambalema* and Havana No. 38 potted plants, was also found to be significant. The mean concentration of the virus in Havana No. 38 was 45.458 ± 2.292 lesions per 10 square centimeters of *N. glutinosa* leaf surface (Table IV); that for the virus in *Ambalema* plants was 4.828 ± 0.468 lesions (Table VI). The difference 40.63 ± 2.34 is clearly not due to chance alone and indicates that on the basis of the number of lesions produced by the plant extracts on *N. glutinosa*, the *Ambalema* variety is more resistant to tobacco mosaic than the Havana No. 38 tobacco.

TABLE IV—THE CONCENTRATION OF THE TOBACCO-MOSAIC VIRUS IN HAVANA No. 38 PLANTS, 13 WEEKS OLD; JUICE EXTRACTED NINE WEEKS AFTER INOCULATION; LESIONS PER 10 SQ. CM. OF LEAF SURFACE OF *N. GLUTINOSA*.

No. of lesions	d^2	M
42.017	11.8405	...
24.892	422.9604	...
30.632	219.8103	...
54.642	84.3459	...
49.770	18.5933	...
52.823	54.2432	...
55.598	102.8196	...
55.925	109.5581	...
41.763	13.6530	...
46.516	1.1194	...
454.578	1038.9437	45.458±2.292

AGE OF PLANT AND VIRUS CONCENTRATION

It was deemed advisable to determine if the virus concentration in the tissues of plants would undergo any changes with age of plant. For this purpose small plants were inoculated when four weeks old and the concentration of the virus was determined by extracting the juice five and nine weeks after inoculation and testing on *N. glutinosa*. Plants were properly numbered so that the same plant could be studied at the two ages given herein. The results appear in Table V.

TABLE V—COMPARISON OF THE VIRUS CONCENTRATION IN *AMBALEMA* PLANTS NINE AND THIRTEEN WEEKS OLD; JUICE EXTRACTED AT FIVE AND NINE WEEKS AFTER INOCULATION; LESIONS PER 10 SQ. CM. OF LEAF SURFACE OF *N. GLUTINOSA*.

Plant No.	Five weeks after inoculation	Nine weeks after inoculation	d^2	M	S. D.
349 a	14.241	1.609	0.626630	...	...
349 b	17.077	5.033	0.041453	...	...
349 c	17.953	5.103	6.810012	...	...
349 d	17.139	7.150	3.427682	...	...
349 e	15.103	5.016	3.074412	...	...
Total			13.980189	11.8404	1.6712

The value of Z was found to be 7.085 which may be taken as 7.1. This value with $n = 5$, gives odds higher than 9999:1 that the difference is not due to chance alone, thus leading to the conclusion that the virus concentration in the resistant plant is lower in plants 13 weeks old than in the same plants at nine weeks of age.

Using Bessel's method for the determination of the probable error and the significance of results, the concentration of the virus at different ages of the plant was studied on the basis of 20 plants of the *Ambalema* variety. The mean number of local lesions produced by the juice of *Ambalema* plants five weeks after inoculation was

18.006 ± 0.875 (Table VI) and that by the juice of the same plants nine weeks after inoculation was 4.828 ± 0.468 (Table VI). The difference of these two observations is 13.178 ± 0.992. This difference is 13.28 times as great as its probable error and therefore can well be attributed to an actual difference in the concentration of the virus in the resistant plant at an age of nine and thirteen weeks and not to chance.

TABLE VI—COMPARISON OF THE VIRUS CONCENTRATION IN *AMBALEMA* PLANTS NINE AND THIRTEEN WEEKS OLD; JUICE EXTRACTED AT FIVE AND NINE WEEKS AFTER INOCULATION; LESIONS PER 10 SQ. CM. OF LEAF SURFACE OF *N. GLUTINOSA*.

Plant No.	Plants 5 weeks after inoculation			Plants 9 weeks after inoculation		
	No. of lesions	d^2	M	No. of lesions	d^2	M
489	2.678	234.9476		10.237	29.2573	
349 a	14.241	14.1752		4.215	0.3758	
349 b	17.077	0.8630		3.328	2.2500	
349 c	17.953	0.0028		4.493	0.1122	
349 g	17.139	0.7517		4.327	0.2510	
369	19.499	2.2290		10.909	36.9786	
370	21.128	9.7469		1.609	10.3620	
371	25.961	63.2820		5.033	0.0420	
372	26.660	74.8917		5.103	0.0756	
373 a	17.257	0.5610		7.150	5.3917	
373 b	12.342	32.0809		5.016	0.0353	
373 c	18.671	0.4422		0.159	21.7996	
373 d	23.661	31.9790		0.324	20.2860	
373 e	15.003	9.0180		1.874	8.7261	
373 f	9.766	67.8976		1.080	14.0475	
373 g	27.167	83.9239		2.751	4.3139	
373 h	17.424	0.3387		8.476	13.3079	
373 i	18.037	0.0010		7.132	5.3084	
373 j	17.113	0.7974		8.012	10.1379	
373 k	21.339	11.1089		5.322	0.2440	
Total	360.116	639.0385	18.006±0.875	96.550	183.3028	4.828±0.468

ATTENUATION

It was thought that if the resistant plant was inherently capable of masking the symptoms or recovering from them, as well as preventing an increase of the virus such as is the case in the tissues of resistant plants, it might influence the virus principle to an extent to which this would be rendered less virulent. The attenuation of pathogenic organisms is of such common occurrence that it is well to take advantage of new materials and tools in order to make an inquiry into the possibilities that lie in the field of immunity against disease.

Attenuation of plant viruses has been reported in several cases. A change in the ordinary tobacco-mosaic virus has been induced by heat (Johnson: **11**) and by the action of oxygen (Johnson and Ogden: **15**).

Attenuation of the virus that causes the curly-top of sugar beet has been reported by Carsner (2, 3) and Lackey (19, 20) by passage through resistant plants and by Carsner & Lackey (4) when passed through resistant varieties of sugar-beet.

From the results of Johnson & Grant (14) it appears that passage of the ordinary tobacco-mosaic virus through *Solanum atropurpureum*, *S. melongena*, *S. miniatum* and *Martynia louisiana* resulted in a lowering of the thermal inactivation point of the virus by several degrees Centigrade; between 5 and 10 degrees. The writers, however, consider that a variation of 5°C is not "of sufficient magnitude to be considered significant in the present state of our knowledge concerning plant viruses."

Grant (7) made four successive transfers of the ordinary tobacco-mosaic virus through young plants of *Phacelia whitlavia*, larkspur, buckwheat, tassel flower and three transfers through French marigold, but his results showed no evidence of attenuation.

Holmes (9) reports a strain of the tobacco-mosaic virus which is masked in *N. tabacum* but otherwise indistinguishable from the latter. It behaves like ordinary tobacco mosaic in response to heat, storage, dilution, suscept range and in production of necrotic symptoms.

Kunkel (18) has recently reported three attenuated strains of the aucuba mosaic of tomato, isolated from plants incubated at high temperatures and three strains of the ordinary tobacco mosaic obtained in a similar manner.

An experiment was made for the purpose of determining the effect of passage of the ordinary tobacco-mosaic and the yellow tobacco-mosaic viruses through the resistant variety *Ambalema*.

Two series, $R^n — S^n$, involved the inoculation of resistant (R) and susceptible (S) Havana No. 38 small tobacco plants at intervals of 10 days as follows: $R^1 — S^0$, meaning the original inoculation; $R^1 — S^1$, meaning the second inoculation, a susceptible plant inoculated with juice extracted from $R^1 — S^0$; the source of inoculum for $R^2 — S^1$ being the juice of $R^1 — S^1$, etc.

Two other series, R^n, involved the repeated inoculation of small resistant *Ambalema* plants at 10-day intervals. The experiment was continued during a period of 100 days when both series ended with inoculation into a susceptible plant.

In order to test for modification of the virus, the extracted juices were inoculated into *N. glutinosa* and Havana No. 38 tobacco.

The results show that no change was effected in the yellow tobacco-mosaic virus, that could be determined by differences in symptom expression.

Similar results were obtained with the series in which the ordinary tobacco-mosaic virus was used as inoculum. It should be observed that the virus was in no case exposed to the attenuating effects of the same plant, for more than ten days. If attenuation of the virus occurs, this experiment proves that a longer association than ten days is necessary between the pathogen and the protoplasm of the suscept for any change to occur. In a second experiment ten *Ambalema* and five Havana No. 38 plants were inoculated at the seedling stage and kept in pots up to the blossoming stage. They were transferred repeatedly from pots and the large-plant stage was reached in ten-inch pots. The presence of the virus in the fifth leaf down from the unopened bud was determined every two weeks. The extracted juice was inoculated into Havana No. 38 tobacco and *N. glutinosa*.

At the end of the experiment it was found that the difference in virulence of the virus had not changed significantly as indicated by the number of local lesions produced in *N. glutinosa* by the extracted juices, and by the symptoms on Havana No. 38. One exception, however, was that of an *Ambalema* plant which had exhibited peculiar yellow interveinal areas on the leaves a week after inoculation. This plant was kept under special observation. Two months after inoculation, the symptoms had disappeared completely from old and new leaves. The extracted juices from this plant produced at this stage on Havana No. 38 a form of mosaic which differed in morphological symptoms from ordinary tobacco mosaic or yellow tobacco mosaic. Suspecting a mixture of viruses which might have occurred accidentally, it was conceived that by repeated inoculation into *N. glutinosa* a separation of elements producing necrosis on this suscept might be attained. Accordingly, the extracted juice from the plant was inoculated into *N. glutinosa*. No dilution was made since the concentrated juice from each lesion had been found in previous tests to produce only two or three local lesions per leaf of *N. glutinosa*. Single spots were carefully dissected out and after thorough maceration in the mortar a few drops of sterile water were added. With the aid of a little cotton wrapped at the end of dissecting needles, the small amount of extract was inoculated into a small plant of the Havana No. 38 tobacco and into a leaf of *N. glutinosa*. Quite surprisingly it was found that both the ordinary tobacco mosaic and the new mild form were obtained from the single spots. The process was repeated with the mild form alone through four additional generations of *N. glutinosa* plants. The successive increase of the virus

and repeated isolation of single spots resulted in the purification of the new virus.

It is of interest to have isolated a form of mosaic with a symptom expression different from the ordinary tobacco mosaic yet producing necrotic local lesions on *N. glutinosa* and capable of producing infection on *Ambalema* tobacco.

The logical procedure seemed to be to compare this form of mild mosaic with the ordinary tobacco mosaic.

Virus concentration.—A comparison of the concentration of the two viruses in Havana No. 38 and *Ambalema* plants was made in the way outlined at the beginning of this paper. The results appear in Tables VII and VIII.

In a series of seven observations it was found that the mean difference in concentration of the ordinary tobacco-mosaic virus and the mild-mosaic virus in *Ambalema* plants was 0.893 lesions with S. D. of 1.047, which represents odds of 22.9 to 1 against this difference being due to chance alone. In a similar series of five observations in Havana No. 38, the mean difference was 11.01 with S. D. of 11.13 and odds of 16.2 to 1. In both cases the odds are too low, indicating an insignificant difference. It may be concluded on the basis of these observations under the conditions of this experiment, that the ordinary tobacco-mosaic virus and the mild-mosaic virus do not differ significantly in their concentration in either resistant or susceptible plants.

TABLE VII—NUMBER OF LESIONS PER 10 SQ. CM. OF *N. GLUTINOSA* LEAF SURFACE PRODUCED BY EXTRACTED JUICES OF INOCULATED *AMBALEMA* PLANTS.

Ordinary tobacco mosaic	Mild Mosaic	d^2	M	S. D.	Z
1.874	0.853	0.0164			
1.080	0.878	0.4775			
2.402	0.450	1.1215			
1.704	0.350	0.2125			
1.413	2.678	4.6570			
2.756	1.742	0.0146			
2.854	0.880	1.1686			
Total		7.6681	0.8931	1.0466	0.9889

TABLE VIII—NUMBER OF LESIONS PER 10 SQ. CM. OF *N. GLUTINOSA* LEAF SURFACE PRODUCED BY EXTRACTED JUICES OF INOCULATED HAVANA No. 38 PLANTS.

Ordinary tobacco mosaic	Mild Mosaic	d^2	M	S. D.	Z
35.789	22.402	5.6501			
46.416	17.531	319.5156			
24.551	18.741	27.0400			
27.571	32.410	251.1908			
42.702	35.746	16.3539			
Total		619.7504	11.010	11.133	0.853

Symptoms.—The morphologic symptoms as explained above are of a mild form and unlike those of ordinary tobacco mosaic in that no leaf distortions or enations have been observed. For a clearer idea of this mosaic, see figs. 23–26.

Nothing is known of the histologic situation. Observations indicate that the physiology of plants affected with this form of mosaic must be different from those infected with the ordinary form since they are able to develop fairly well and bear good seed.

Temperature relations.—Three different experiments to determine the thermal inactivation point of the mild-mosaic virus showed that it lies between 86° and 90°C., like the checks of ordinary tobacco-mosaic virus.

It was not inactivated at 85°C. This correspondence with ordinary tobacco-mosaic virus should be of some significance in the interpretation of these results.

Discussion

A point of interest not raised in our previous paper (**21**) is the fact that according to current hypotheses a case of resistance to mosaic within the species *N. tabacum* would not have been expected to be very frequent. The ordinary tobacco-mosaic virus is certainly one of wide occurrence. Suffice it to mention that its host range has been recently extended by Grant (**7**) to include 29 non-solanaceous species distributed in 14 widely separated families. Our discovery, therefore, does not easily fall within the postulates advanced by Vavilov (**25**) who claimed that the chances for occurrence of immune or resistant plants would be least for species of pathogens with a weak degree of pathogenetic specialization.

The results herein presented show that plants of the *Ambalema* variety always become infected provided that inoculation is properly done. It has also been demonstrated that infection will occur at any age of the suscept. It is further shown that symptoms of a very mild character will appear on small plants but that the plants have the capacity to outgrow the symptoms and the new growth appears free from chlorosis. From the commercial and practical standpoint this is of more than ordinary interest. It has been generally conceded by workers with the mosaic of tobacco that infection in the field or seed-bed arises when the workers handling the small plants have the habit of chewing tobacco. Valleau and Johnson (**24**) Fukushi (**6**) and Busch and Wolf (**1**) have determined by experiment that many commercial brands of tobacco serve as sources of inoculum.

There remains no doubt that a variety of tobacco which can escape the injurious effects consequent to infection at the time of transplanting should prove valuable in the hands of both the practical grower and the scientific investigator. This is especially true if one bears in mind the futility of efforts in the rogueing of tobacco-mosaic infected plants. Wolf (27) is of the opinion that the rogueing of seed-beds is inadvisable. Most investigators who have had field experience with this disease will agree that much harm will often result from this method of eradication unless the laborers are intelligent and extremely careful.

The use of the number of local lesions produced on *N. glutinosa* by the extracted juices is the only method at hand to express in quantitative terms the concentration of the virus principle in the tissues of its host; but at best it is only of relative value. A modification of the method has been made here involving the expression of concentration on the basis of measured areas, in this case ten square centimeters of leaf surface. The variety *Ambalema* has been considered as resistant because the measure of the virus concentration in its tissues as represented by the number of local lesions per ten square centimeters of *N. glutinosa* leaf surface has been shown to be significantly lower than that of the juice from a known susceptible variety. Other factors inherent in the plant may be responsible for the low virus concentration. The resistance in the *Ambalema* variety, therefore, may be defined as the capacity of the *Ambalema* system to prevent the increase of the virus in its tissues at the same high rate as is characteristic of susceptible plants.

The *Ambalema* tobacco was found to be very susceptible to other known viruses of tobacco. It succumbs quickly to the effects of spot-necrosis and Wingard's tobacco ring-spot and more slowly to potato ring-spot and cucumber-mosaic viruses. The degree of susceptibility is difficult to estimate in the case of the mottle and vein-banding viruses although the symptoms appear in the leaves. In these cases we may be dealing with a mild tolerance to infection. The fact that it exhibits its highest resistance to yellow tobacco-mosaic and ordinary tobacco-mosaic viruses raises an important question. Is there really so much difference between these two viruses? Johnson (12) is quite convinced that they are different, though closely related. We only wish to call attention, in passing, to the similar reaction exhibited by the resistant variety to infection by both viruses.

That the virus concentration in resistant plants was higher in plants five weeks old than in the same plants at the age of thirteen

weeks may mean that the virus is increasing at a lower rate in the older plant. Another explanation may be that the virus principle becomes diluted with the expansion of the leaf blades. It would not be easy to conceive of the destruction of some of the virus principle in the larger and older plants.

The isolation of an apparently new virus from resistant plants inoculated with the virus of the ordinary tobacco mosaic may be explained as a case of attenuation of the latter.

On the basis of the symptom expression alone the mild mosaic can be differentiated from the ordinary tobacco mosaic. That the thermal inactivation point, the virus concentration and the production of local necrotic lesions is like in ordinary tobacco mosaic may indicate that the mild-mosaic virus is not very far removed from the latter. It will be a question as to whether the difference in symptom expression alone has enough weight to lead one to regard the two viruses as different from each other. Johnson (**12**) has already pointed out that symptoms may be of little diagnostic value in differentiating between plant viruses.

It may also be attributed to a separation of another mosaic virus or of a factor contained in the tobacco-mosaic virus. This would necessitate thinking of the tobacco-mosaic virus as a mixture of factors which may be separated from their combination. Since the known properties of the ordinary tobacco-mosaic virus are exhibited by the mild-mosaic virus and this differs from the former only in the resulting symptoms, there should be no objection to regarding the mild mosaic as an attenuated form whose parasitic and pathogenic capacity has been changed or altered in degree but not in character.

Whether this modification has been influenced by the protoplasm of the resistant plant in part or in its entirety, or whether other factors extraneous to the plant have played the major or perhaps the complete role, has not been ascertained in these studies.

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SUMMARY

1. Infection of the resistant tobacco variety *Ambalema* occurs at all ages.

2. Symptoms in resistant plants ordinarily consist of clearing of the veins followed by small chlorotic interveinal areas of a mild type.

3. Infection occurs and mild or severe symptoms appear in transplants when these are inoculated at time of pulling. These plants later recover in the field, but the virus is always contained in their tissues.

4. Infection of *Ambalema* plants was determined by inoculation of the juices extracted from those plants into *N. glutinosa* and Havana No. 38 tobacco.

5. *Ambalema* tobacco is also resistant to yellow tobacco mosaic, and celery mosaic. It should not be forgotten that symptoms are produced in inoculated plants but the effects produced by the disease are not very significant.

6. By adequate quantitative studies it was determined that the *Ambœlema* tobacco is significantly more resistant to ordinary tobacco mosaic than Havana No. 38 tobacco at all stages of growth.

7. *Ambalema* tobacco is very susceptible to cucumber mosaic, yellow cucumber mosaic, potato ring-spot, Wingard's tobacco ring-spot and spot-necrosis, and somewhat less susceptible to the mottle and veinbanding viruses.

8. The virus concentration was found to be lower in inoculated resistant plants nine weeks after inoculation (13 weeks old) than five weeks after inoculation (9 weeks old).

9. A mild form of mosaic was isolated from resistant plants inoculated with the ordinary tobacco-mosaic virus. In its properties this mosaic virus seems similar to the ordinary tobacco-mosaic virus. This may possibly be regarded as a case of attenuation.

DEPARTMENT OF AGRICULTURE AND COMMERCE,
SAN JUAN, PUERTO RICO

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Explanation of Plates

Plate I.—Ordinary tobacco mosaic.

Fig. 1. Clearing of veins, early stage, *Ambalema* leaf.
2. Advanced stage of infection, leaf of *Ambalema* tobacco.
3. Virulent form of infection with much yellowing, *Ambalema* tobacco.
4. Uninoculated check, Havana No. 38 tobacco.

Plate II.—Ordinary tobacco mosaic. (Plants of same age.)

Fig. 5. Inoculated check, Havana No. 38 tobacco.
6. Uninoculated check, *Ambalema* tobacco.
7. Advanced stage of infection, *Ambalema* tobacco.

Plate III.—Ordinary tobacco mosaic. (Plants six weeks old.)

Fig. 8. Leaves from infected plant of *Ambalema.*
9. Leaves from infected plant of Havana No. 38.

Plate IV.—Ordinary tobacco mosaic. (Plants of same age.)

Fig. 10 and 12. Infected *Ambalema* plants.
11. Uninoculated check, *Ambalema* plant.

PLATE V.—Ordinary tobacco mosaic. (Plants of same age.)

Fig. 13. Infected plant, Havana No. 38.

14. Infected plant, *Ambalema.*

PLATE VI.—Various virus diseases on *Ambalema.*

Fig. 15. Leaf infected with the yellow tobacco-mosaic virus. (Note tendency of yellow areas to be more conspicuous along margin of blade.)

16. Leaf infected with Wingard's tobacco ring-spot virus.

17 and 18. Leaves infected with the yellow cucumber-mosaic virus.

19. Uninoculated check, leaf of *Ambalema.*

PLATE VII.—Cucumber mosaic on *Ambalema.* (Plants inoculated in greenhouse and transplanted to the garden.)

Fig. 20 and 22. Plants infected with the cucumber-mosaic virus.

21. Check plant, infected with the ordinary tobacco-mosaic virus.

PLATE VIII.—Attenuation of the ordinary tobacco-mosaic virus.

Fig. 23 and 26. Leaves of Havana No. 38 tobacco showing symptoms of an attenuated form of tobacco mosaic.

24. Uninoculated check. Havana No. 38 tobacco.

25. Inoculated check, Havana No. 38 tobacco inoculated with the ordinary tobacco-mosaic virus.

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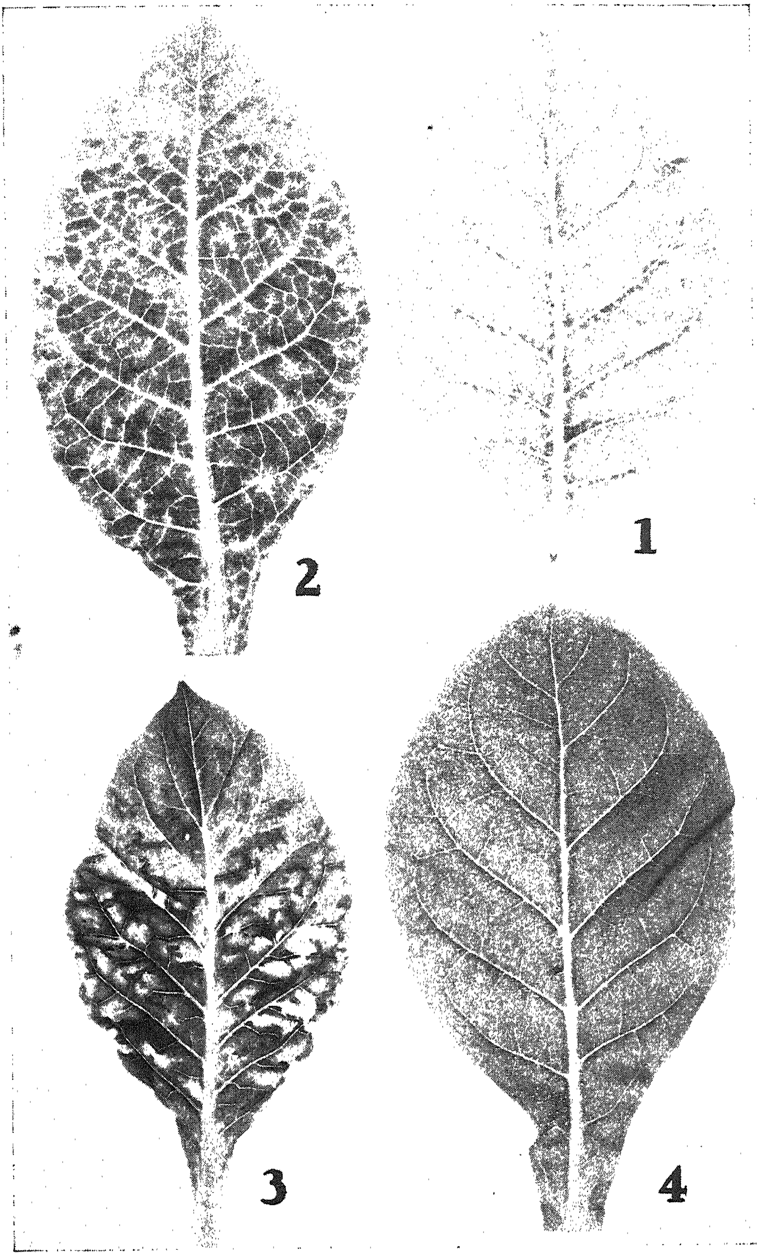
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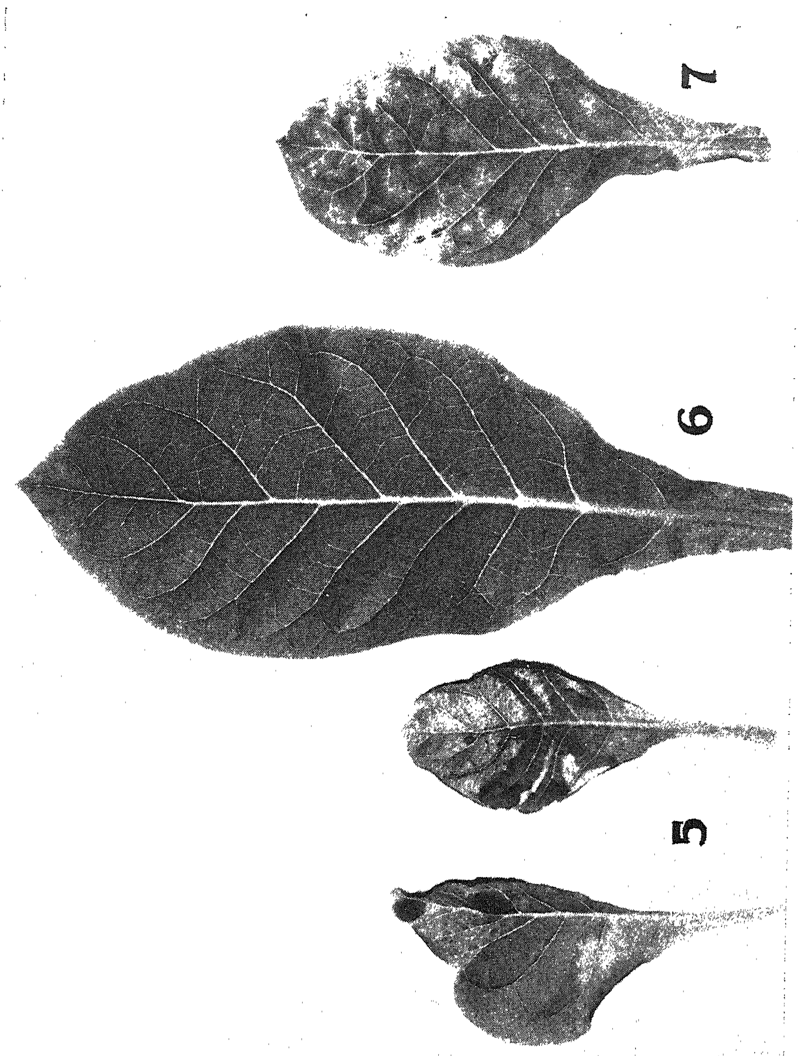
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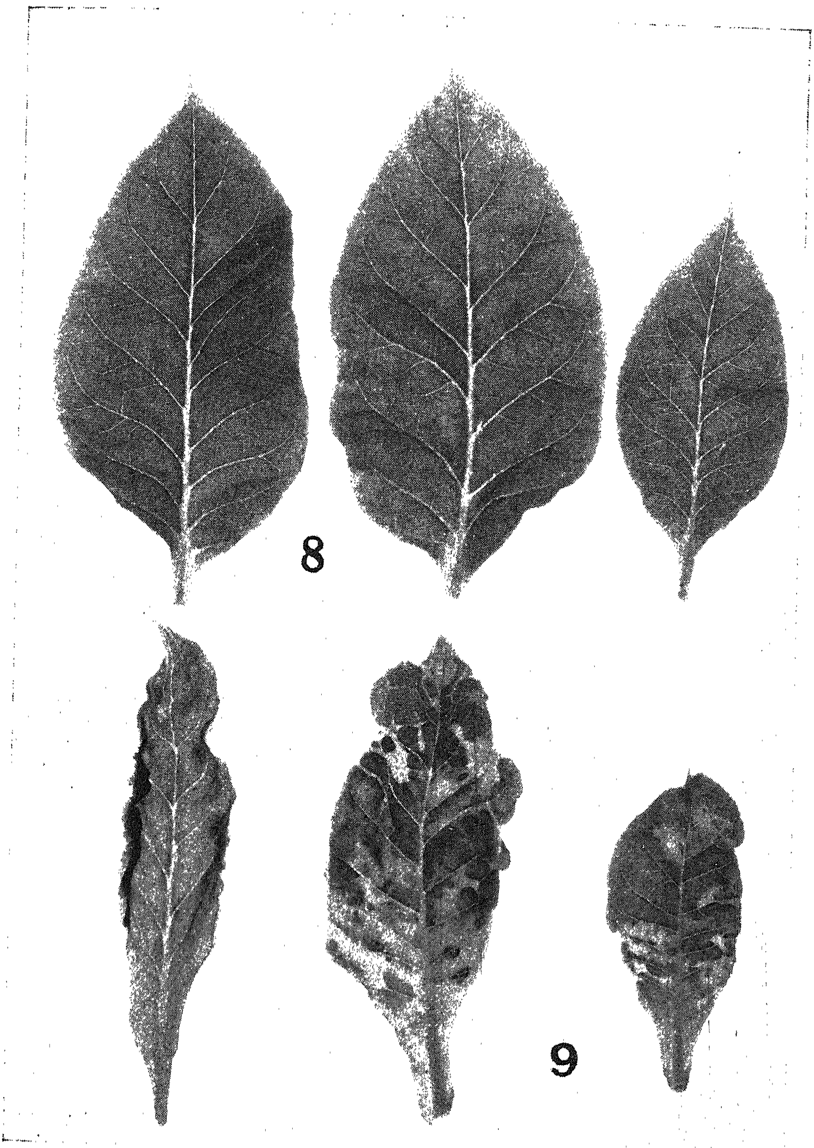

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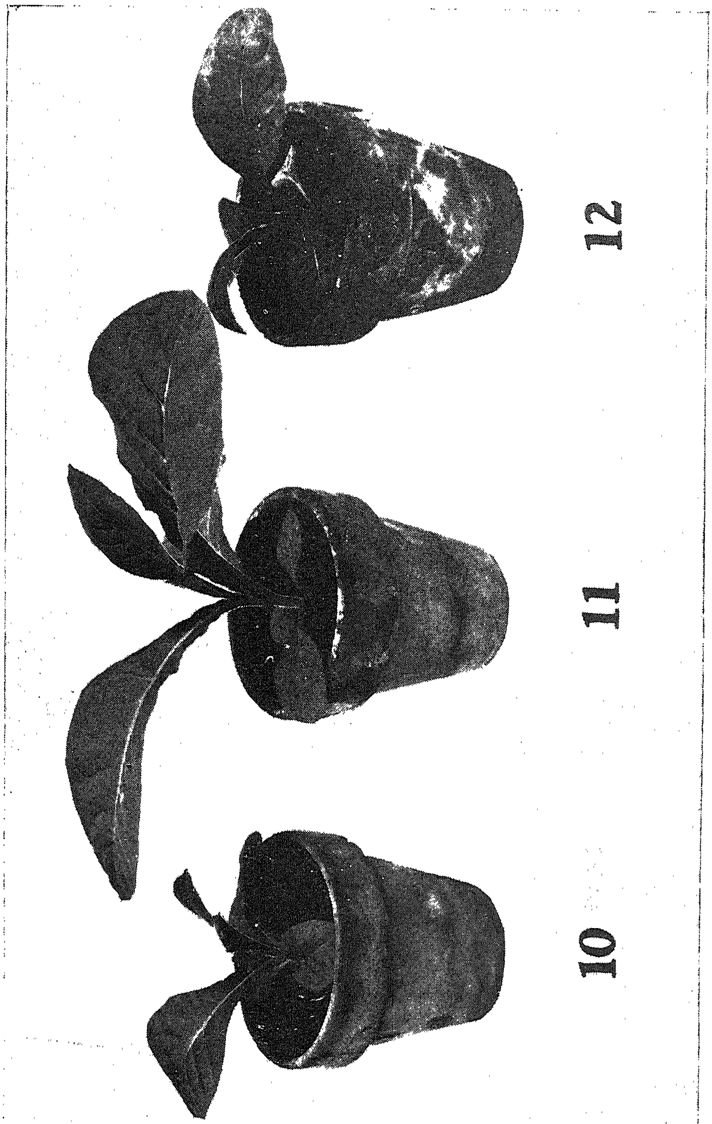

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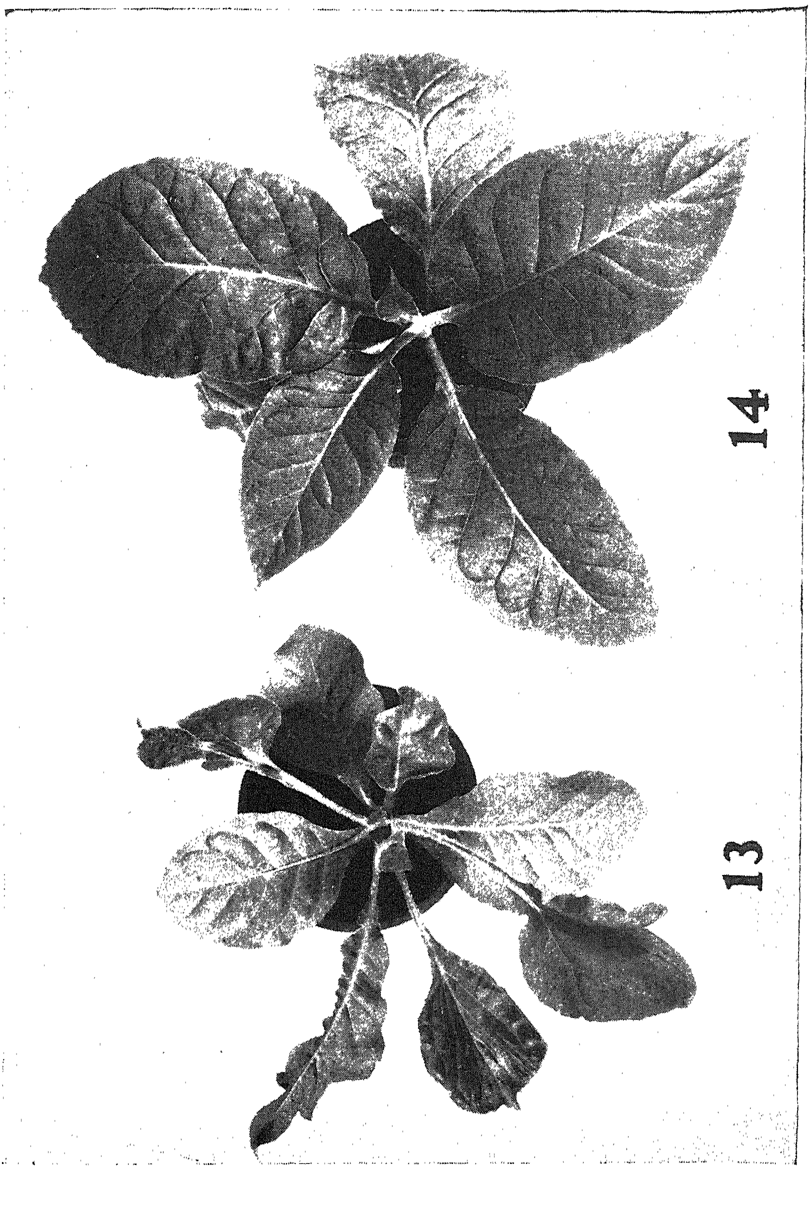

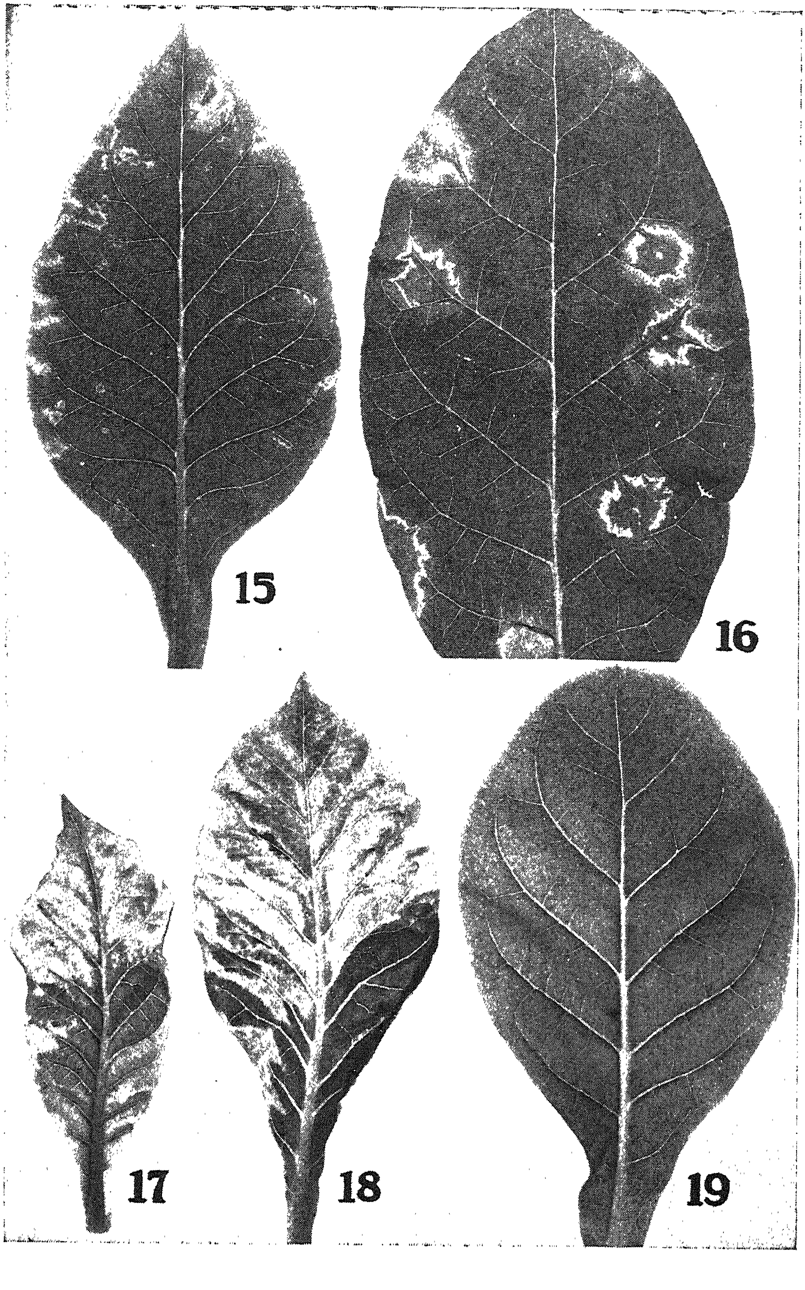
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Plate VII

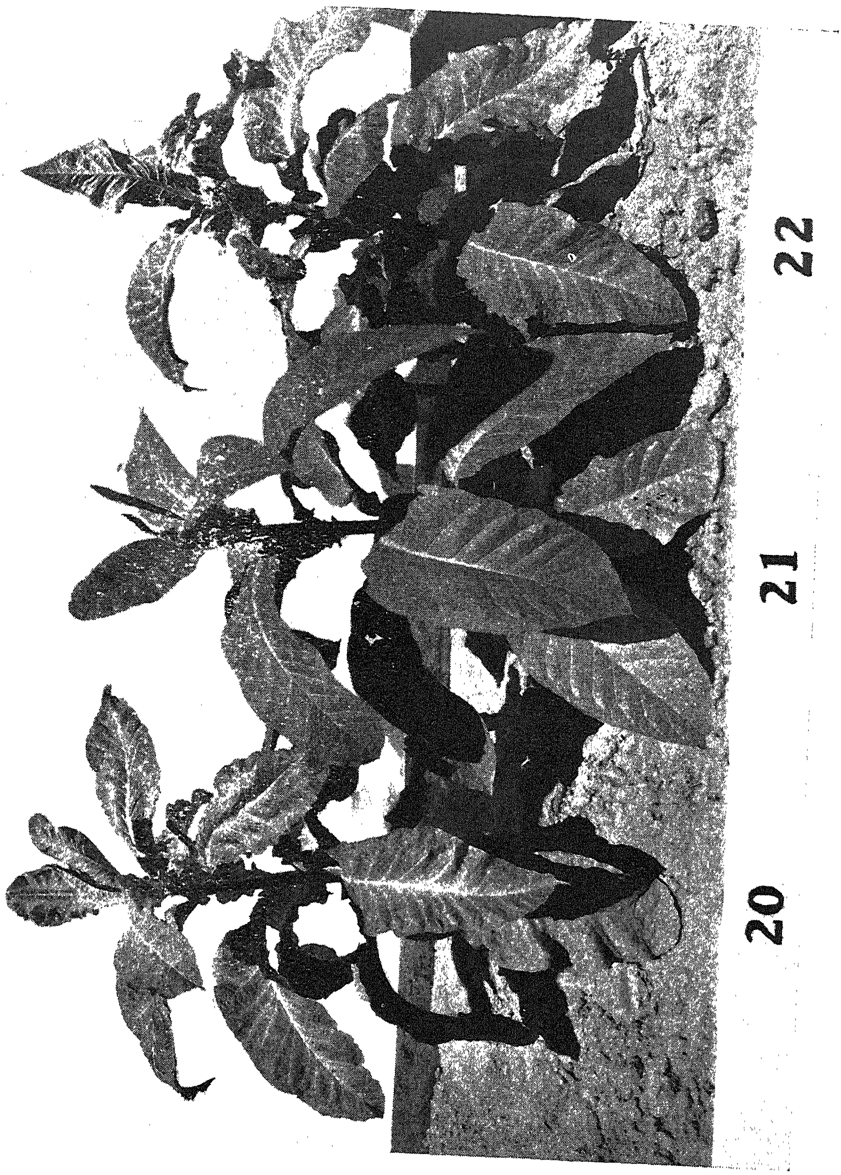
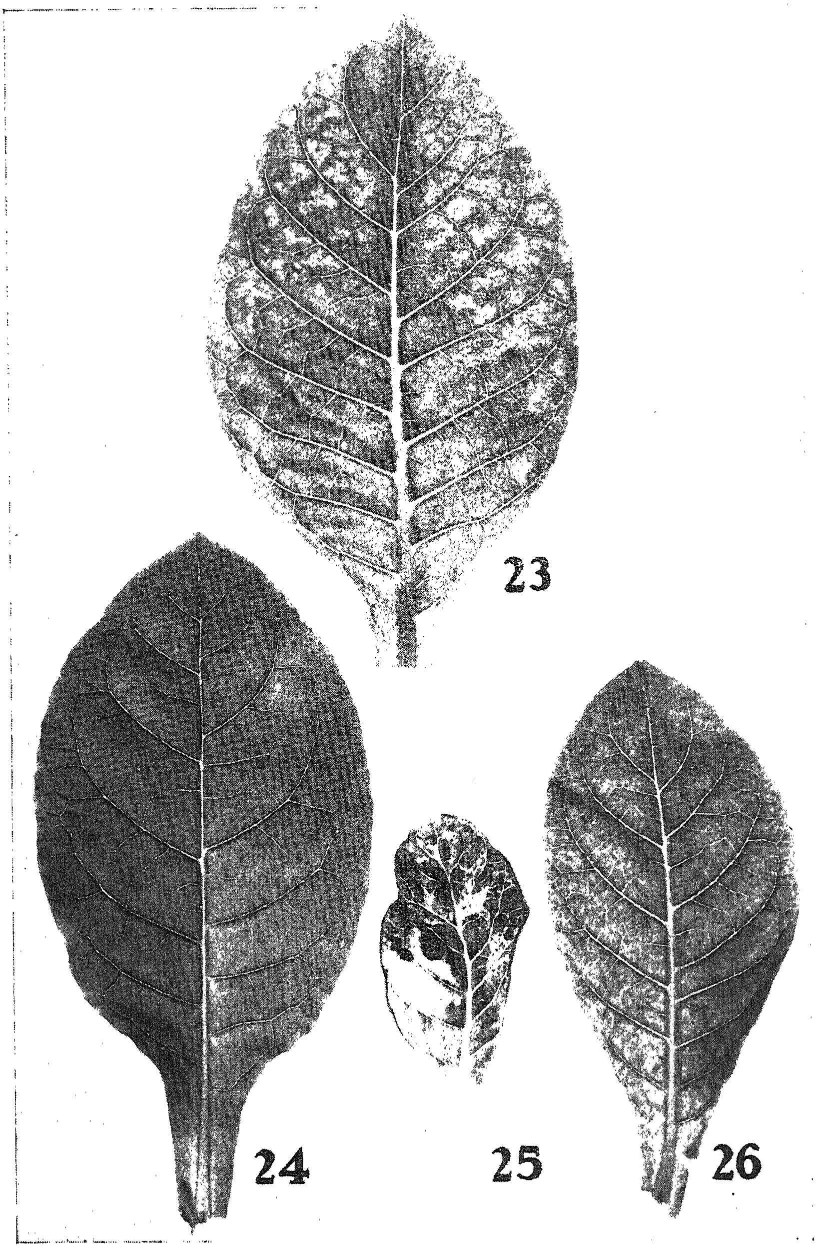


Plate VIII



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NEW CERAMBYCID BEETLES FROM PUERTO RICO

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Among the material received during the past year from Puerto Rico for identification, the following twelve new species of Cerambycidae were found.

Tilloclytus puertoricensis, new species

Small, elongate, slightly depressed above, nearly glabrous, subopaque; head black; pronotum black anteriorly, reddish at base; elytra reddish, with a broad, transverse, white fascia at middle, the fascia arcuately emarginate in front at sutural margins and bordered anteriorly by a narrow, black fascia, each elytron with an elongate, black spot along lateral margin extending from the white fascia backward to near apex and inward to middle of elytron; antenna and under side of body black or reddish brown, with bases of tibiae and femora, posterior part of prosternum, anterior part of mesosternum, and basal joints of antennae yellowish or reddish.

Head with the front wider than long, flat between the antennal tubercles, which are widely separated, but not elevated; surface densely, finely granulose, coarsely, confluently punctate, sparsely clothed with short, recumbent, inconspicuous, white hairs, with a few long, erect, white hairs around the eyes; eyes small, oblong, strongly convex, but not emarginate. Antenna extending to basal third of elytra, the outer joints slightly enlarged; first joint long, cylindrical, slightly arcuate, slightly expanded toward apex, subequal in length to the third and fourth joints united; third joint twice as long as the fourth, which is distinctly shorter than the fifth.

Pronotum one-half longer than wide, distinctly narrower at base than at apex, widest along middle; sides nearly parallel at middle, slightly rounded anteriorly, strongly constricted at base; disk strongly convex anteriorly, transversely depressed on basal third; surface finely, densely granulose, coarsely, deeply alveolate-punctate, clothed with a few long, erect, stiff, whitish hairs. Scutellum small, elongate, rounded at apex, slightly pubescent.

Elytra nearly one and three-fourths times as long as pronotum, at base slightly wider than pronotum at middle; sides nearly parallel from base to behind middle, where they are feebly, arcuately expanded, then arcuately narrowed to the tips, which are conjointly broadly rounded; disk strongly flattened on basal halves, strongly convex on apical halves; surface coarsely, deeply alveolate-punctate, with a few long, erect, stiff, white hairs posteriorly, each elytron with

a narrow vitta of short, recumbent, yellowish white hairs along sutural margin at apex.

Abdomen beneath smooth, shining, nearly glabrous; last segment broadly rounded at apex. Prosternum very sparsely, feebly punctate, feebly, transversely rugose, nearly glabrous; prosternal process very narrow between the coxal cavities, strongly expended posteriorly, truncate at apex. Metasternum and mesosternum with a small spot of dense, recumbent, whitish pubescence on each side. Legs rather long, smooth, clothed with a few scattered, long, erect, white hairs; femora strongly, abruptly, clavate toward apices, petiolate at bases; tibiae long, subcylindrical.

Length, 3 — 4.25 mm; width, 0.88 — 1.3 mm.

Type locality—Guánica, Puerto Rico.

Type and paratypes.—U. S. National Museum, No. 51019.

Remarks.—Described from three specimens (one type) collected in decaying wood on the Borinquen Forest Reservation, October 3, 1934, by R. G. Oakley (San Juan No. 5854).

This species is closely allied to *minutus* Fisher, but it differs from that species in having the basal part of the pronotum and basal halves of elytra reddish.

Lamproclytus oakleyi, new species

Elongate, nearly parallel, moderately convex above, strongly shining, above and beneath uniformly dark reddish brown, the pronotum slightly darker, each elytron ornamented with a transverse, eburneous fascia.

Head with the front strongly transverse, flat between the antennal tubercles, which are widely separated and slightly elevated; surface coarsely alveolate-punctate, sparsely clothed with long, semierect, white hairs. Antenna extending just beyond base of elytron, basal joints cylindrical, slightly expanded toward apices, clothed with a few long, erect, white hairs, apical joints broader, slightly flattened, rather densely clothed with short, recumbent pubescence, with a few long, erect intermixed; first joint robust, cylindrical, about twice as long as the second joint, which is two-thirds as long as the third; tenth joint oval, acutely rounded at apex.

Pronotum distinctly longer than wide, slightly wider at apex than at base, widest at middle; sides strongly, arcuately rounded from apex to basal sixth, where they are strongly constricted and parallel; disk strongly convex, feebly, transversely flattened along anterior margin, strongly, transversely constricted at base; surface coarsely alveolate-punctate, sparsely clothed with short, inconspicuous pubescence, and numerous long, erect, stiff, white hairs. Scutellum elongate-triangular, rather densely clothed with short, semierect pubescence.

Elytra twice as long as pronotum, at base subequal in width to pronotum at middle; sides nearly parallel, feebly, very broadly, arcuately constricted at middle, the tips separately broadly rounded or subtruncate; disk feebly, broadly, transversely depressed at middle, vaguely, broadly elevated along sutural margins behind scutellum; surface very coarsely, deeply, irregularly punctate, clothed with a few long, erect, stiff, white hairs, each elytron ornamented behind the

middle with a rather broad, transverse, eburneous fascia, extending from lateral margin to near the sutural margin.

Abdomen beneath very sparsely, feebly punctate, clothed with a few long, erect, white hairs; last segment broadly rounded at apex. Prosternum sparsely, coarsely punctate, rather densely clothed with moderately long, recumbent, whitish pubescence; prosternal process narrow, strongly expanded behind the coxal cavities. Legs sparsely clothed with long, erect, stiff, white hairs; anterior pair slightly shorter than middle and posterior pairs; femora strongly, abruptly clavate toward the tips, petiolate at bases; tibiae straight and subcylindrical.

Length, 3.25 mm; width, 0.85 mm.

Type locality.—Ponce, Puerto Rico.

Type.—U. S. National Museum, No. 51020.

Remarks.—Described from a single specimen collected on *Tabebuia* sp. at the Guánica Central Finca, September 21, 1933, by R. G. Oakley (San Juan No. 4693).

This species is closely allied to *elegans* Fisher, but it differs from that species in being uniformly dark reddish brown.

Leptostylus albosignatus, new species

Strongly robust, moderately convex, slightly flattened above, reddish brown to brownish black, rather densely clothed with brownish white and dark brown pubescence, the elytra ornamented with a large, distinct, irregular, square, whitish pubescent spot at middle, common to both elytra.

Head with the front quadrate, slightly convex, feebly depressed between the antennal tubercles, which are strongly elevated and obliquely divergent, with a narrow, longitudinal groove extending from occiput to epistoma; surface indistinctly punctate, densely, irregularly clothed with long, recumbent, brownish white pubescence, nearly concealing the surface, causing a slightly variegated appearance; eyes separated from each other on the top by twice the width of the upper lobe. Antenna about one-third longer than the body, variegated with white and brownish pubescence, the outer joints annulated with brown pubescence.

Pronotum three-fourths wider than long, subequal in width at base and apex, widest at middle; sides sinuate anteriorly, parallel posteriorly, tumid on each side at middle; disk feebly, tranversely depressed along base and anterior margin, with seven obtusely rounded tubercles arranged in two transverse rows on disk, four in front and three behind, the three median tubercles more strongly elevated than the four exterior ones; surface coarsely, deeply, irregularly punctate between the tubercles, and with a row of coarser punctures in the basal and anterior depressions, densely clothed with long, recumbent, brownish white pubescence, and ornamented with six small, dark brown pubescent spots, two along anterior margin and four along base. Scutellum transverse, broadly rounded at apex, rather densely pubescent.

Elytra three-fourths longer than wide, slightly wider than pronotum at middle; humeri prominent, slightly elevated; sides nearly parallel from base to apical fourth, then arcuately narrowed to the tips, which are separately narrowly, obliquely truncate internally, the exterior angle obtuse and feebly produced;

disk uneven, with numerous irregularly distributed, rather acute tubercles, those in the basal region more strongly developed; surface coarsely, deeply, irregularly punctate, the punctures becoming finer and sparser toward apices, densely clothed with long, recumbent, brownish white and dark brown pubescence, ornamented with an irregular, square, white pubescent spot at middle, common to both elytra, and with a few small, dark brown pubescent spots posteriorly.

Beneath nearly smooth, rather densely clothed with long, recumbent, brownish white pubescence, the legs variegated with whitish and brownish pubescence; tibiae feebly annulated with brown pubescence; prosternal process as wide as the coxal cavity.

Length, 9.5 — 12 mm; width, 4 — 4.75 mm.

Type locality.—Ponce, Puerto Rico.

Type and paratype.—U. S. National Museum, No. 51021.

Remarks.—Described from two specimens (one type). The type was collected at the type locality during December 1933 by C. Rinaldi, and the paratype was collected at light at the Lesesne Finca, Bayamón, Puerto Rico, November 12, 1933, by Rae Lesesne and C. G. Anderson (San Juan No. 4855).

This species is allied to *antillarum* Fisher, but it differs from that species in having a distinct, large, white, pubescent spot on the elytra.

Leptostylus oakleyi, new species

Elongate, slightly flattened above, reddish brown to brownish yellow, densely clothed with brownish yellow pubescence, and ornamented with dark brown or black pubescence.

Head with the front quadrate, slightly convex, feebly depressed between the antennal tubercles, which are strongly elevated and obliquely divergent, with a narrow, longitudinal groove extending from occiput to epistoma; surface indistinctly punctate, rather densely, irregularly clothed with long, recumbent, brownish white pubescence, nearly concealing the surface, causing a variegated appearance; eyes separated from each other on the top by the width of the upper lobe. Antenna about one-fourth longer than the body, variegated with brown and white pubescence, the joints annulated with dark brown pubescence.

Pronotum nearly twice as wide as long, subequal in width at base and apex, widest at middle; sides obliquely expanded from base to near middle, arcuately expanded at middle, parallel posteriorly; disk feebly, transversely flattened along base and anterior margin, with three vague, round protuberances, two arranged transversely in front and one behind; surface coarsely, deeply, irregularly punctate, with a row of similar punctures along base and anterior margin, densely clothed with long, recumbent, brownish white pubescence, irregularly ornamented around the dorsal protuberances with brownish pubescence, and with a distinct brown pubescent vitta on each side below the lateral protuberance. Scutellum broadly triangular, broadly rounded at apex, sparsely pubescent.

Elytra twice as long as wide, distinctly wider than pronotum at middle; humeri not prominent; sides parallel to behind middle, then arcuately narrowed to the tips, which are separately obliquely truncate internally; disk uneven, with

a few inconspicuous tubercles clothed with blackish hairs near the base; surface densely clothed with long, recumbent, brownish white pubescense, and each elytron ornamented with black pubescence as follows: A large, elongate spot along lateral margin; a short, narrow, oblique fascia along sutural margin behind middle; a narrow, arcuate fascia at lateral margin at apical fifth; an irregular, inconspicuous spot near apex; and with a few small, irregularly distributed, round spots.

Beneath obsoletely granulose, rather densely clothed with long, recumbent, whitish pubescence, the sternum and legs variegated with white and brown pubescence; tibiae annulated with brown pubescence; femora strongly pedunculate; prosternal process one-half as wide as the coxal cavity.

Length, 4.5 mm; width, 1.8 mm.

Type locality.—Bayamón, Puerto Rico.

Type.—U. S. National Museum, No. 51022.

Remarks.—Described from a single specimen collected at light at the Lesesne Finca, March 10, 1934, by Rae Lesesne and C. G. Anderson (San Juan No. 5257).

This species is allied to *gundlachi* Fisher, but it differs from that species in the different arrangement of the brown pubescence on the elytra, and in having a broad, dark brown, pubescent vitta on each side of the pronotum.

Leptostylus nigricans, new species

Small, elongate, moderately flattened above, brownish yellow, with the basal halves of elytra, disk of pronotum, tips of antennal joints, tarsi, and parts of head, tibiae, and femora, black or dark brown and rather densely pubescent.

Head with the front quadrate, slightly convex, feebly depressed between the antennal tubercles, which are rather strongly elevated and obliquely divergent, with a narrow, longitudinal groove extending from occiput to epistoma; surface indistinctly punctate, rather sparsely, irregularly clothed with long, recumbent, brownish yellow pubescence, with a few white and dark brown hairs intermixed, the brown hairs more numerous on the occiput; eyes separated from each other on the top by twice the width of the upper lobe. Antenna about one-fourth longer than body, variegated with white and brown pubescence, the joints annulated with dark brown pubescence.

Pronotum nearly twice as wide as long, subequal in width at base and apex, widest at basal third; sides feebly, obliquely expanded to basal third, then strongly, arcuately narrowed to near the base, parallel and strongly constricted at base; disk even, narrowly, tranversely grooved along base and anterior margin, the margins elevated; surface indistinctly punctate, rather densely, irregularly clothed with long, recumbent, black and reddish brown pubescence. Scutellum triangular, narrowly rounded at apex, densely pubescent.

Elytra nearly twice as long as wide, slightly wider than pronotum at basal third; humeri not prominent; sides parallel to behind middle, then arcuately narrowed to the tips, which are separately narrowly rounded; disk even, with a distinct tubercle clothed with long, black hairs near base of each elytron; surface

coarsely, densely, deeply punctate from bases to apices, the basal black area with the posterior margin extending obliquely backward from the sutural margin at middle to lateral margin at apical third, sparsely clothed with short, black hairs, with an irregular spot beneath the humerus and a few small spots at middle clothed with brownish yellow pubescence, the apical pale area densely clothed with long, recumbent, brownish yellow pubescence, and narrowly margined anteriorly with white pubescence.

Beneath feebly granulose, rather densely clothed with long, recumbent, whitish pubescence, the sternum and legs variegated with white and brown pubescence; tibiae annulated with brown pubescence; femora strongly pedunculate; prosternal process three-fourths as wide as coxal cavity.

Length, 4 mm; width, 1.75 mm.

Type locality.—Villalba, Puerto Rico.

Type.—U. S. National Museum, No. 51023.

Remarks.—Described from a single specimen collected in vegetative debris at the Insular Government Finca, June 18, 1934, by R. G. Oakley (San Juan No. 5666).

This species is allied to *dorsalis* Fisher, but it differs from that species in being shorter and more robust, and in having the pronotum broader, with the sides more broadly rounded at the basal third, and each elytron armed with a distinct basal tubercle and narrowly rounded at the apex.

Leptostylus puertoricensis, new species

Small, elongate, moderately flattened above, brownish black to brownish yellow, rather densely pubescent.

Head with the front slightly transverse, slightly convex, feebly depressed between the antennal tubercles, which are rather strongly elevated and obliquely divergent, with a narrow, longitudinal groove extending from occiput to epistoma; surface indistinctly punctate, sparsely, irregularly clothed with long, recumbent, brownish yellow pubescence, the pubescence dark brown on the occiput; eyes separated from each other on the top by twice the width of the upper lobe. Antenna about as long as the body, variegated with white and brown pubescence, the joints annulated with dark brown pubescence.

Pronotum twice as wide as long, subequal in width at base and apex, widest at basal third; sides obliquely expanded to basal third, then strongly, arcuately narrowed to near the base, parallel and strongly constricted at base; disk even, narrowly, transversely grooved along base and anterior margin; surface indistinctly punctate, densely clothed with long, recumbent, brownish yellow and brownish black pubescence. Scutellum triangular, narrowly rounded at apex, densely pubescent.

Elytra two-thirds longer than wide, and slightly wider than pronotum at basal third; humeri not prominent; sides parallel to behind middle, then arcuately narrowed to the tips, which are separately obliquely subtruncate internally; disk even, with a small tubercle clothed with black hairs near base of each elytron; surface rather densely, finely punctate from bases to apices, rather densely clothed

with long, recumbent, brownish yellow pubescence, each elytron with a more or less distinct, broad, whitish pubescent fascia, extending obliquely backward from the sutural margin at middle to the lateral margin at apical third, and ornamented with brownish black pubescence as follows: A large, semioval spot along lateral margin in front of midddle; an irregular area around basal tubercle; a narrow, irregular, interrupted, oblique fascia behind the whitish pubescent fascia; and a few small, irregularly distributed, round spots.

Beneath feebly granulose, rather densely clothed with long, recumbent, whitish pubescence, the sternum and legs variegated with white and brown pubescence; tibiae annulated with brown pubescence; femora strongly pedunculate; prosternal process one-half as wide as coxal cavity.

Length, 4 mm; width, 1.75 mm.

Type locality.—Adjuntas, Puerto Rico.

Type.—U. S. National Museum, No. 51024.

Remarks.—Described from a unique specimen collected on an unknown tree at the Pietri Finca, June 10, 1933, by R. G. Oakley (San Juan No. 4304).

This species is allied to *planicollis* Fisher, but it differs from that species in having the upper surface clothed with brownish yellow and brownish black pubescence, and each elytron ornamented near the middle with a broad, oblique, whitish pubescent fascia.

Eugamandus oakleyi, new species

Short, oblong, strongly convex, subopaque, uniformly reddish or yellowish brown, each elytron ornamented laterally with an irregular, black pubescent vitta.

Head with the front strongly transverse, nearly flat, flat between the antennal tubercles, which are widely separated and feebly elevated, with a vague, longitudinal groove extending from occiput to epistoma; surface sparsely, coarsely, uniformly punctate, rather densely clothed wtih short, scalelike, golden yellow and brownish hairs, with a few longer, semierect, whitish hairs intermixed; eyes small, narrow, rather deeply emarginate separated from each other on the top by nearly four times the width of the upper lobe. Antenna nearly as long as the body, annulated with short, recumbent, yellowish white and dark brown pubescence; first joint robust, subcylindrical, flattened beneath at base, subequal in length to the fourth joint, which is slightly shorter than the third, the following joints shorter and nearly equal in length.

Pronotum distinctly wider than long, subequal in width at base and apex, widest at middle; sides arcuately expanded at middle, parallel posteriorly; disk strongly convex, slightly uneven, more or less transversely gibbose at middle, broadly, transversely flattened posteriorly; surface coarsely, sparsely, deeply punctate, the punctures denser toward the sides, irregularly variegated with dense, short, scalelike, brownish yellow and dark brown hairs, with a few longer, semierect, whitish hairs intermixed. Scutellum strongly transverse, broadly rounded at apex, broadly concave, and clothed with scalelike hairs, which are dark brown at the middle and whitish on each side.

Elytra two and two-thirds times as long as pronotum, at base distinctly

wider than pronotum; sides nearly parallel from base to behind middle, then arcuately narrowed to the tips, which are seperately narrowly rounded; disk strongly convex, uneven, slightly flattened above, obliquely declivous behind middle, slightly elevated near apices; surface coarsely, sparsely, deeply punctate, variegated with dense, short, scalelike, brownish yellow and dark brown hairs, the hairs slightly paler toward apices, with a few long, erect, whitish hairs toward lateral margins, each elytron ornamented with a black pubescent vitta extending along lateral margin from humeral angle to basal third, then inward and backward to posterior declivity, and with numerous, strongly elevated, irregularly distributed tubercles, the largest located on middle of elytron at posterior declivity.

Abdomen beneath finely granulose, coarsely, densely, deeply punctate, rather densely clothed with short, scalelike, yellowish and whitish hairs, with a few longer, erect, whitish hairs intermixed; last segment broadly rounded at apex.

Length, 5.75 mm; width, 3 mm.

Type locality.—Matrullas Dam, near Orocovis, Puerto Rico

Type.—U. S. National Museum, No. 51025.

Remarks.—Described from a single specimen collected in decaying wood at the Insular Government Finca, October 8, 1934, by R. G. Oakley (San Juan No. 5861).

This species is allied to *schwarzi* Fisher, but it differs from that species in being more strongly convex and in having the elytra distinctly tuberculate.

Eugamandus brunneus, new species

Small, short, oblong, strongly convex, subopaque, uniformly dark reddish brown with the tarsi, antennae, and tibiae, in part, yellowish, and above irregularly variegated with black and brownish, scalelike hairs.

Head with the front strongly transverse, nearly flat, flat between the antennal tubercles, which are widely separated and feebly elevated, with a vague, narrow, longitudinal groove extending from occiput to epistoma; surface coarsely, sparsely, uniformly punctate, rather densely clothed with short, scalelike, golden yellow and brownish hairs, with a few longer, erect, whitish hairs intermixed; eyes small, narrow, deeply emarginate, separated from each other on the top by three times the width of the upper lobe. Antenna nearly as long as the body, rather densely clothed with short, recumbent pubescence; first joint robust, subcylindrical, flattened beneath at base, subequal in length to the fourth joint, which is three-fourths as long as the third, the following joints shorter and nearly equal in length.

Pronotum distinctly wider than long, subequal in width at base and apex, widest at middle; sides arcuately expanded at middle, parallel posteriorly; disk strongly convex, slightly uneven, more or less transversely gibbose at middle, broadly, transversely flattened posteriorly; surface coarsely, deeply, sparsely, irregularly punctate, the punctures denser toward the sides, irregularly variegated with dense, short, scalelike, brownish yellow and dark brown hairs. Scutellum similar to *oakleyi* Fisher.

Elytra nearly three times as long as pronotum, and at base distinctly wider than pronotum; sides nearly parallel from base to behind middle, then arcuately narrowed to the tips, which are separately narrowly rounded or subtruncate; disk strongly convex, uneven, slightly flattened above, obliquely declivous behind the middle; surface coarsely, sparsely, deeply punctate, variegated with dense, short, scalelike, brownish yellow and dark brown hairs, each elytron with an indistinct, irregular, blackish pubescent spot toward lateral margin, and ornamented with two longitudinal rows of tubercles, the inner row distinct and composed of three tubercles, the outer one less distinct.

Abdomen beneath finely granulose, feebly, coarsely, sparsely punctate, sparsely clothed with short, scalelike, whitish hairs, with a few longer, erect hairs of the same color intermixed; last segment broadly subtruncate at apex.

Length, 3.75 mm; width, 1.85 mm.

Type locality.—Yauco, Puerto Rico.

Type.—U. S. National Museum, No. 51026.

Remarks.—Described from a single specimen collected in vegetative debris at the Augustin Finca, in the mountains north of Yauco, June 15, 1934, by R. G. Oakley (San Juan No. 5654).

This species is very closely allied to *oakleyi* Fisher, but it differs from that species in being much smaller and more slender, and in having the tubercles on each elytron arranged in two longitudinal rows.

Eugamandus flavipes, new species

Small, short, oblong strongly convex, feebly shining, uniformly pale reddish brown, with the legs and the antennae yellowish, above more or less variegated with black and brownish, scalelike hairs.

Head with front strongly transverse, nearly flat, flat between the antennal tubercles, which are widely separated and feebly elevated, with a vague, narrow, longitudinal groove on occiput and vertex; surface coarsely, sparsely, uniformly punctate, densely clothed in front with moderately long, recumbent, yellow pubescence; eyes small, narrow, deeply emarginate, separated from each other on the top by four times the width of the upper lobe. Antenna nearly as long as the body, densely clothed with short, recumbent pubescence; first joint robust, subcylindrical, flattened beneath at base, subequal in length to the third and fourth joints, the following joints shorter and gradually diminishing in length.

Pronotum distinctly wider than long, narrower at apex than at base, widest at middle; sides arcuately expanded at middle, slightly parallel posteriorly; disk strongly convex, more or less gibbose at middle, rather broadly, transversely flattened along base and anterior margin; surface coarsely, deeply, sparsely punctate, more densely toward the side, rather densely clothed with short, scalelike, black hairs on median part, sparsely clothed with scalelike, whitish hairs at sides, and ornamented with a narrow, more or less interrupted, median vitta of similar white hairs. Scutellum similar to that of *oakleyi* Fisher.

Elytra two and one-half times as long as pronotum, at base distinctly wider than pronotum; sides nearly parallel from base to behind middle, then arcuately

narrowed to the tips, which are conjointly broadly rounded; disk strongly, uniformly convex, arcuately declivous posteriorly; surface coarsely, rather densely, deeply punctate, variegated with rather dense, short, scalelike, yellowish brown and dark brown hairs, each elytron ornamented with two irregular-shaped, black pubescent spots near middle, and two strongly elevated tubercles, one at basal fourth, the other just behind the middle.

Body beneath coarsely, rather densely punctate, sparsely clothed with short, recumbent, whitish hairs, with a few scalelike hairs intermixed; last segment broadly rounded or subtruncate as apex.

Length, 2.75 mm; width, 1.25 mm.

Type locality.—Villalba, Puerto Rico.

Type.—U. S. National Museum, No. 51027.

Remarks.—Described from a single specimen collected in vegetative debris at the Insular Govenment Finca, June 18, 1934, by R. G. Oakley (San Juan No. 5667).

This species is allied to *oakleyi* Fisher, but it differs from that species in having the elytra evenly convex, arcuately declivous posteriorly, and each elytron armed with only two distinct tubercles.

Cyrtinus eugeniae, new species

Very small, elongate, feebly shining; head, pronotum, and abdomen dark reddish brown; antennae, legs, and elytra slightly paler, the latter dark reddish brown along lateral margins.

Head with the front strongly transverse, feebly convex, flat between the antennal tubercles, which are widely separated and scarcely elevated, without a distinct, longitudinal groove; surface coarsely, deeply, confluently punctate, rather densely clothed with long, semierect, whitish hairs; eyes small, coarsely granulated, distinctly divided, separated from each other on the top by twice the width of the upper lobe, which is slightly smaller than the lower lobe. Antenna 11-jointed, about as long as the body, sparsely clothed with long and short hairs; first joint extending to apical third of pronotum, gradually expanded toward apex, one-half longer than third joint, which is subequal in length to the fourth, the following joints gradually diminishing in length.

Pronotum slightly longer than wide, distinctly narrower at base than at apex, widest along apical fourth; sides feebly expanded anteriorly, strongly constricted at basal fourth, then parallel to base; disk strongly convex anteriorly, narrowly, transversely flattened along base; surface coarsely, deeply, confluently punctate, sparsely, clothed with rather short, recumbent, whitish hairs.

Elytra twice as long as wide, slightly wider than pronotum near apex; sides nearly parallel, slightly, arcuately expanded behind middle, then arcuately narrowed to the tips, which are conjointly broadly rounded; disk transversely flattened on basal half, moderately convex posteriorly; surface coarsely, deeply, densely punctate basally, the punctures becoming obsolete near apices, sparsely, irregularly clothed with moderately long, recumbent, white hairs, with a few long, erect hairs intermixed.

Abdomen beneath vaguely punctate, sparsely clothed with short, inconspicuous hairs; last segment broadly rounded at apex. Legs sparsely clothed with short, recumbent, whitish hairs; femora strongly, abruptly clavate toward apices, the club scarcely flattened laterally.

Length, 2 mm; width, 0.63 mm.

Type locality.—Aibonito, Puerto Rico.

Type.—U. S. National Museum, No. 51028.

Remarks.—Described from a single specimen collected on *Eugenia* sp. at the Díaz Finca, October 6, 1933, by R. G. Oakley (San Juan No. 4768).

This species is allied to *hubbardi* Fisher, but it differs from that species in being much smaller, feebly shining, and coarsely, confluently punctured on the upper surface.

Cyrtinus subopacus, new species

Small, elongate, subopaque; head, pronotum, tarsi, and abdomen black or dark reddish brown; antennae, legs and elytra pale brownish yellow, the latter with a large black spot on each side toward lateral margin.

Head with the front flat, strongly transverse, flat between the antennal tubercles, which are widely separated and scarcely elevated, with a vague, narrow, longitudinal groove extending from epistoma to occiput; surface densely, finely granulose, coarsely, deeply, confluently punctate, sparsely clothed with long, recumbent, whitish hairs; eyes small, coarsely granulated, distinctly divided, separated from each other on the top by six times the width of the upper lobe, which is considerably smaller than the lower lobe. Antenna 11-jointed, about as long as the body, clothed with a few long and short hairs; first joint extending to apical third of pronotum, gradually expanded toward apex, twice as long as the third joint, which is subequal in length to the fourth; the following joints gradually decreasing in length.

Pronotum slightly longer than wide, distinctly narrower at base than at apex, widest near apex; sides feebly narrowed from apex to basal fourth, where they are strongly constricted, then parallel to base; disk strongly convex anteriorly, narrowly, transversely flattened along base, with a narrow, transverse groove at basal fourth; surface coarsely, deeply, confluently punctate, sparsely clothed with short, recumbent, whitish hairs.

Elytra twice as long as wide, slightly wider than pronotum near apex; sides parallel from base to apical fourth, then arcuately narrowed to the tips, which are conjointly broadly rounded; disk transversely flattened on basal half, moderately convex posteriorly; surface coarsely, deeply, confluently punctate, the punctures elongate, becoming obsolete near apices, sparsely, irregularly clothed with moderately long, recumbent, withish pubescence.

Abdomen beneath feebly, coarsely, sparsely punctate, sparsely clothed with fine, semierect hairs; last segment broadly rounded or subtruncate at apex. Legs sparsely clothed with short, recumbent, white hairs; femora strongly, abruptly clavate toward apices, the club slightly flattened laterally.

Length, 2.5 mm; width, 0.75 mm.

Type locality.—Adjuntas, Puerto Rico.

Type.—U. S. National Museum, No. 51029.

Remarks.—Described from a single specimen collected flying, at the Pietri Finca, April 13, 1933, by R. G. Oakley (San Juan No. 3984).

This species is allied to *eugeniae* Fisher, but it differs from that species in being larger and subopaque, and in having the punctures on the elytra elongate.

Cyrtinus oakleyi, new species

Very small, elongate, strongly shining; head and pronotum black or dark reddish brown, the latter with the base narrowly brownish yellow; elytra pale brownish yellow, each with a large, irregular black or reddish brown spot behind the middle, and a similar, but smaller, spot at apex; antenna pale brownish yellow with the joints darker at apices; beneath dark reddish brown, with the tibiae and tarsi pale brownish yellow.

Head with the front strongly transverse, feebly convex, flat between the antennal tubercles, which are widely separated and scarcely elevated, without a distinct longitudinal groove; surface vaguely granulose, coarsely, densely, rather deeply punctate, sparsely clothed with long, recumbent, whitish hairs; eyes small, coarsely granulated, distinctly divided, separated from each other on the top by about four times the width of the upper lobe, which is considerably smaller than the lower lobe. Antenna 11-jointed, about as long as the body, clothed with a few long and short hairs; first joint extending to middle of pronotum, gradually expanded toward apex, about twice as long as the third joint, which is slightly longer than the fourth, the following joints gradually decreasing in length.

Pronotum as wide as long, distinctly narrower at base than at apex, widest near apex; sides feebly narrowed from apex to basal fourth, where they are strongly constricted, then parallel to the base; disk strongly convex anteriorly, narrowly, transversely flattened along base, with a narrow, transverse groove at basal fourth; surface densely, coarsely, deeply punctate, and nearly glabrous.

Elytra twice as long as wide, slightly wider than pronotum near apex; sides parallel from base to apical third, then arcuately narrowed to the tips, which are conjointly broadly rounded; disk slightly flattened on basal half, moderately convex posteriorly; surface coarsely, rather densely punctate basally, the punctures becoming obsolete toward apices, sparsely, irregularly clothed with short, recumbent, white hairs, with a few long, erect hairs intermixed.

Abdomen beneath vaguely punctate, nearly glabrous; last segment subtruncate at apex. Legs sparsely clothed with short, recumbent, whitish hairs, more densely pubescent on outer margin of femora, which are strongly, abruptly clavate toward apices, the club slightly flattened laterally.

Length, 1.75 mm; width, 0.6 mm.

Type locality.—Yauco, Puerto Rico.

Type and paratype.—U. S. National Museum, No. 51030.

Remarks.—Described from two specimens (one type) collected in decaying plants at the Augustin Finca, in the mountains north of Yauco, June 2, 1934, by R. G. Oakley (San Juan No. 5625).

This species is allied to *eugeniae* Fisher, but it differs from that species in being strongly shining, and in having the pronotum as wide as long, and each elytron ornamented with two reddish brown spots.

NEW EUCNEMID BEETLES FROM PUERTO RICO

By W. S. Fisher

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Among the material received during the past year from Puerto Rico for identification, the following four new species of Eucnemidae were found.

Dirhagus puertoricensis, new species

Body narrow, subcylindrical, attenuate posteriorly, reddish black, legs yellow, pubescence inconspicuous, ornamented with whitish pubescence as follows: Sides and base of pronotum, a broad, transverse fascia at base and a similar, more conspicuous fascia at apical third of elytra. Head convex in front, coarsely, confluently punctate. Antenna extending to middle of abdomen, joint 3 elongate, joint 4 triangular, joints 5 to 11 pectinate. Pronotum wider than long, parallel, depressed posteriorly, carinate in front of scutellum, densely ocellate-punctate; posterior angles carinate. Elytra attenuate posteriorly, depressed at base, densely punctate. Beneath coarsely, densely punctate. Length, 2.75 mm.

Type in United States National Museum, collected on coffee at the Paraiso Finca, Ponce, P. R. July 13, 1933, by R. G. Oakley (San Juan No. 4315).

Differs from *D. phyrrhopus* Chevrolat in being nearly black, and in having the antennae pectinate and the elytra ornamented with two transverse, whitish pubescent fasciae.

Dirhagus oakleyi, new species

Body narrow, subcylindrical, attenuate posteriorly, black, with posterior angles of pronotum, scutellum, basal two-thirds of sutural margins and basal halves of elytra, and sides of mesosternum and metasternum reddish brown, legs yellow, sparsely clothed on sides of pronotum with whitish pubescence, a vague, irregular, transverse fascia of whitish pubescence near middle of elytra, each elytron with a broad, transversely oblique fascia of golden yellow pubescence at apical third. Head convex in front, confluently ocellate-punctate. Antenna extending to middle of abdomen, joint 3 narrow, elongate, joint 4 triangular, joints 5 to 11 flabellate. Pronotum wider than long, parallel, carinate in front of scutellum, densely ocellate-punctate; posterior angles carinate. Elytra attenuate posteriorly, densely punctate. Beneath coarsely, densely punctate. Length, 2.6 mm.

Type in United States National Museum, collected on *Eugenia* sp. at the Rivera Finca, Aibonito, P. R., May 31, 1934, by R. G. Oakley (San Juan No. 5617).

Differs from *D. puertoricensis* Fisher in having the elytra bicolored, with a golden yellow pubescent fascia at apical third, and the antennae flabellate.

Nematodes puertoricensis, new species

Body very narrow, subcylindrical, dark reddish brown, legs and antennae paler, pubescence uniform, yellowish white. Head convex in front, uniformly, finely, densely punctate. Antenna with joints 2, 4 and 5 subequal, joints 6 to 10 slightly longer, broader, subequal, last joint longer, acute at apex. Pronotum parallel, slightly longer than wide, vaguely biimpressed on each side, finely, confluently punctate. Elytra strongly attenuate posteriorly, indistinctly striate, finely, densely punctate. Beneath finely, densely punctate, antennal grooves indistinct, posterior coxae strongly angulated. Length, 5 mm.

Type and paratype in United States National Museum, collected on weeds at the Insular Government Finca, Matrullas Dam, near Orocovis, P. R. October 8, 1934, by R. G. Oakley (San Juan No. 5859).

Differs from *N. simulans* Chevrolat in being much smaller, and in having the intermediate antennal joints as wide as long, and the elytra not distinctly striate.

Adelothyreus insularis, new species

Body narrow, subcylindrical, black, with an elongate, brownish yellow spot covering the exterior three-fourths of each elytron, the spot not extending to base or apex, tarsi and palpi yellow, pubescence sparse, uniform, whitish. Head convex in front, confluently ocellate-punctate. Antenna extending to posterior coxae, joint 3 slightly serrate, joints 5 to 11 strongly transverse. Pronotum quadrate, parallel, feebly flattened, depressed posteriorly, with 3 elevations at base, densely ocellate-punctate; posterior angles carinate. Elytra nearly parallel, depressed at bases, rugose basally, coarsely, densely punctate posteriorly. Beneath densely, coarsely punctate, more feebly on abdomen. Length, 3—3.25 mm.

Type and paratype in United States National Museum collected by R. G. Oakley. The type was collected on *Eugenia* sp. at the Rivera Finca, Aibonito, P. R., May 31, 1934 (San Juan No. 5617), and the paratype was collected at Castaner Finca, Adjuntas, P. R., February 5, 1934 (San Juan No. 5206).

Differs from *A. dufaui* Fleutiaux in having the antennal joints strongly transverse, the elytra more parallel, pubescence whitish, with a large brownish yellow spot covering the exterior three-fourths of each elytron.

NEW SPECIES OF SCARABAEIDAE (COLEOPTERA) FROM PUERTO RICO AND THE VIRGIN ISLANDS

By EDWARD A. CHAPIN,
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As it will probably be some considerable time before a projected revision of the Puerto Rican and Virgin Island species of Scarabaeidae can appear, it seems desirable to establish names for certain new species which have come to my attention. I am indebted to Dr. Stuart T. Danforth, Mr. R. G. Oakley and to the American Museum of Natural History for the gift or loan of the material described below.

Canthochilum hispidum, new species

Piceous, legs dark castaneous, antennae and mouth parts paler. Entire dorsal surface set with very short, capitate hairs, most densely placed on pronotum and along the elytral striae. Head nearly smooth, minutely punctured except for two oval patches of coarser punctures on the vertex, one patch on either side of the slightly elevated median line. Eyes large, transverse diameter of eye equal to one-fifth distance between eyes. Clypeus quadridentate with middle pair of teeth acute and slightly recurved, genal angles also slightly prominent, each tooth or prominence with a tuft of setae above and below. Pronotum transverse, almost twice as wide as long, basal margin very broadly curved, sides parallel to apical fifth where they turn suddenly toward the median line, anterior angles distinct, posterior angles wanting, underside deeply excavated in anterior third for reception of anterior femora, excavation bounded by a strong carina. Surface strongly shagreened, densely and moderately coarsely punctured. Elytra more shining, less convex than pronotum, very finely striate, seventh stria bounded almost to apex by the strong lateral carina which is broadly interrupted just before its extremity, third interspace with a strong, blunt, subapical spine. Eight striae composed of large punctures and located on the inflexed portion along a second carina. Under surface smooth, without setae, sternites crowded along median line, pygidium subtriangular, margin strongly beaded. Anterior femora strong, not alate, middle femora small and slender, tarsi of anterior legs feeble, strongly compressed, those of other legs well developed, not noticeably compressed, heavily clothed with pale pubescence. Claws minute.

Male: Pronotum strongly gibbous, anterior tibia slender, somewhat bent and enlarged in apical fourth, with three lateral teeth, of which the basal is a little remote from the others and with a single ventral tooth near insertion of tarsus; posterior femora broadly expanded in middle portion.

(1) Published with permission of the Secretary of the Smithsonian Institution.

Female: Pronotum moderately convex, anterior tibia moderately broad, with three lateral teeth situated in the apical third but without a ventral tooth.

Length: 5.5 — 6.2 mm.

Type locality: Villalba, Puerto Rico.

Type and twelve paratypes: U. S. Nat. Mus. Cat. No. 51079.

Material examined: Eight males and five females from the Insular Government Finca at Villalba, collected Sept. 7, 1934 by Mr. R. G. Oakley.

Because of the vestiture of capitate hairs, all specimens seen of this species have been almost completely covered with a layer of dirt, most difficult to remove.

Canthochilum andyi, new species

Piceous to deep black, anterior margin of head and legs castaneous, antennae and mouth parts paler. Resembles *C. histeroides* Harold but larger and with more strongly punctured elytral striae. Head almost smooth, most finely shagreened and with a patch of minute punctures on vertex between eyes. Clypeus quadridentate, the middle teeth more slender than the lateral, almost equidistantly spaced, genal angles slightly prominent, each tooth or prominence with hair tufts above and below. Eyes large, nearly divided by canthus. Pronotum transverse, visibly shagreened only at sides, not visibly punctured except under high magnification; basal margin very broadly rounded, sides parallel to apical fourth, thence sharply convergent to the obtuse anterior angles. Under side excavated in anterior third for reception of femora, excavation bounded posteriorly by carina. Elytra distinctly shagreened, striae well defined and moderately coarsely punctured, the punctures larger toward apical extremity. Seventh stria bounded by lateral carina which ends near apical fourth. Eight stria on inflexed portion and bounded by a carina which reaches almost to extreme apex of suture. Under parts and pygidium as in preceding species. Anterior femora thickened, anterior tibiae coarsely denticulate in addition to the usual three teeth.

Male: Pronotum somewhat gibbous, posterior femora broadly expanded in middle portion, anterior tibiae rather slender, the teeth moderately long and acute in fresh specimens, middle tibiae somewhat, posterior tibiae strongly, arcuate and gradually widened to apices.

Female: Pronotum not more convex than is usual, posterior femora not expanded, anterior tibia moderately broad, middle and posterior tibiae feebly arcuate and gradually widened to apices.

Length: 5 — 5.5 mm.

Type locality: Matrullas, Puerto Rico.

Type and fifteen paratypes: U. S. Nat. Mus. Cat. No. 51080.

Material examined: Four males and twelve females from the Insular Government Finca at Matrullas Dam, near Orocovis, collected October 8, 1934 by Mr. R. G. Oakley.

Cyclocephala danforthi, new species

Similar to *Cyclocephala vincentiae* Arrow in size and form. Testaceous, vertex piceous. Lower portion of frons and upper portion of clypeus moderately strongly and confluently punctured, lower portion of clypeus shining, clypeal margin feebly reflexed laterally, strongly so at the broadly rounded anterior margin. Antenal club of male very large, one third longer than distance between eyes. Pronotum with lateral margins subangulate at middle, sparsely, and rather finely punctured. Scutellum very finely punctured at sides. Elytra with faintly indicated rows of punctures, the interspaces rather coarsely and sparsely punctured. Underparts slightly darker in color than upper, metasternum finely and closely punctured except at middle and on either side adjacent to hind coxae. Pygidium closely and finely granulate. Anterior tibiae tridentate, anterior tarsus of male short and stout, the third to fifth segments with striated areas on inner faces, fifth segment strongly inflated. Claws of anterior tarsus very dissimilar in size, the larger broad and bifurcated in apical fourth, the rami dissimilar and widely divergent.

Length: 11 mm.

Type locality: Great Bay, St. Martin, Virgin Islands.

Type: U. S. Nat. Mus. Cat. No. 51081; paratype in collection of Dr. S. T. Danforth.

Material examined: Two males from the above-mentioned locality colected Dec. 23, 1927, by Dr. S. T. Danforth.

Epiphileurus puertoricensis, new species

Near *Epiphileurus cribratus* Chevrolat but larger with less coarsely punctured pronotum and with quite different aedeagus. Head sparsely set with ill defined punctures, frons of male with a deep, circular pit which is puncture-free, of female slightly concave with a few coarse punctures. Apex of clypeus acute and reflexed, horns over the antennal insertion short, stout and obtuse. Pronotum with an ill-defined median groove which bears a few medium-sized ocellate punctures, rest of surface sparsely punctured, the punctures coarse on disc either side of median groove and very fine along the lateral and basal margin. Anterior angles acute and produced, posterior angles rounded. Elytra with rows of ocellate punctures, the rows somewhat paired, so that the sutural, second, fourth and sixth interspaces are more elevated than the first, third and fifth. Lateral portions of underside with large, ocellate punctures. Pygidium coarsely and rather sparsely punctured, strongly convex in male, less so in female. Anterior tibia tridentate, the teeth slender and acute. Anterior tarsi similar in the sexes.

Length: 15 — 16 mm.

Type locality: Villalba, Puerto Rico; also from Barranquitas, P. R.

Type and nine paratypes: U. S. Nat. Mus. Cat. No. 51082.

Material examined: One male from the Insular Government, Finca, Villalba, collected Oct. 26, 1933, by Mr. R. G. Oakley; seven

males and one female from same locality, June 29, 1934, Oakley; one male and three females from Barranquitas, collected Dec. 1930 by Mr. R. Colón and received for study from Dr. S. T. Danforth and American Museum of Natural History. Two paratypes, male and female, returned to Dr. Danforth, one female paratype returned to the American Museum.

Phyllophaga yunqueana, new species

Large, subdepressed, color yellow brown with head, pronotum and elytra rich reddish castaneous with a dense bluish-white bloom conspicuous only in certain lights. Legs pale with tibiae and tarsi slightly darker. Head moderately coarsely, evenly but sparsely punctured, clypeo-frontal suture deep, clypeus slightly tumid, a little more sparsely punctured than frons, margin gradually reflexed, median indentation broad and shallow. Antenna nine-segmented, club shorter than stem. Pronotum with sides subangulate at middle, anterior angles not at all produced, basal angles rounded, lateral marginal bead broken at intervals, a long hair arising from each break. Elytra with sutural margin slightly tumid, apices of suture minutely mucronate, discal costae obsolete, punctures similar in size to, but more densely placed than those on pronotum. Epipleura very narrow except at base. Pygidium strongly convex in male, coarsely and subconfluently punctured. Underparts rather densely and finely punctured at sides, sparsely so at middle. Anterior tibia strongly tridentate in both sexes, the upper tooth somewhat remote from middle. Tarsi moderately long, posterior tibia slender, hardly expanded at apex, calcaria slender, the longer noticeably longer than the first tarsal segment. Claws strongly curved, the median tooth strong.

Length: 23 mm.

Type locality: El Yunque Mt., Luquillo Range, Puerto Rico.

Type: U. S. Nat. Mus. Cat. No. 51083. Paratype in American Museum of Natural History.

Material examined: A male collected February 1900 by Dr. Leonhard Stejneger; a female collected Oct. 4, 1919, in the collection of the American Museum of Natural History.

Phyllophaga discalis, new species

Below medium size, yellowish to reddish brown, elytra and flanks of pronotum reddish brown, head and disc of pronotum deep castaneous. Head with frons coarsely and confluently punctured, with a deeply impressed median line, clypeo-frontal suture deep, clypeus with punctures similar to those on frons, margin narrowly reflexed, median indentation broad, shallow and not angulate. Antennae nine-segmented, club shorter than stem. Pronotum notably transverse and convex, sides subangulate at middle, anterior angles obtuse, not produced, basal angles rounded, lateral marginal bead broken in a few places and with long hairs at breaks. Elytra with sutural margin slightly tumid, apices of sutural bead minutely mucronate, discal costae absent, rather more finely and densely punctured than pronotum. Epipleura very narrow. Pygidium only slightly convex in male, sparsely and not coarsely punctured.

Under parts finely and densely punctured at sides, very sparsely so at middle. Anterior tibia tridentate in both sexes, the basal tooth a little remote from middle. Posterior tibia slender, not greatly expanded apically. Calcaria of posterior tibia narrow, the longer half again as long as the first tarsal segment. Tarsi moderately long, claws not strongly curved, tooth stout, situated a little beyond middle.

Length: 13 — 15 mm.

Type locality: Yauco, Puerto Rico.

Type and paratypes: U. S. Nat. Mus. Cat. No. 51084.

Material examined: A male from Natalie Finca, in the mountains north of Yauco, Aug. 9, 1934, collected in the ground by Mr. R. G. Oakley; one male and one female from Añasco, P. R., Oct. 16, 1930, by Mr. J. A. Zalduondo.

The aedeagus of this species departs radically from the usual type found among the West Indian species. It is elongate tubular, with the apical margin somewhat modified and bears a striking resemblance to the type commonly found among the species of the Philippines. I have checked the specimens against our entire Asiatic series without success. The similarity may be due to convergent evolution or it may be that at some time Asiatic cane has been introduced into the island.

NITRIFICATION STUDIES WITH SOIL TYPES IN NORTHERN PUERTO RICO

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SCIENTIFIC POINTS RELATIVE TO SOIL NITRIFICATION

The suggestion of Pasteur in 1862 that nitrification is due to bacterial action led Winogradsky in 1890 to isolate the organisms concerned in nitrification processes. Since then, nitrification studies have been a subject of investigation in various soils located in countries of different climatic conditions. Among the various aspects studied is worth while mentioning: Nitrification as influenced by soil moisture, temperature, seasonal variations, plant growth, carbon-nitrogen ratio, buffering agents, application of fertilizers and amendments; occurrence, isolation, limiting and optimum pH of soil nitrifying bacteria; nitrification and solubilization of certain soil inorganic elements; methods of studying soil nitrification and nitrifying capacity of a soil as an index of fertility.

It is a well known fact that the soil nitrifying organisms are of an autotrophic nature characterized by the property of obtaining carbon from the carbon dioxide of the atmosphere and their energy by the oxidation of simple inorganic compounds in the form of ammonium salts, and that the process is carried on in two stages: first by a group of bacteria oxidizing ammonia to nitrites (nitrosomonas, nitrosococcus), and then by another group of bacteria oxidizing nitrites to nitrates (nitrobacter). But Gopala Rao and Dhar (13) claim that nitrification in the soil is at least partly photochemical, taking place without the agency of bacteria under the action of sunlight at the surface of various soil photocatalysts like alumina and titania. In further experiments Gopala Rao (12) says: "The slow oxidation of ammonia in aqueous solution to nitrite has been shown to take place in transparent silica vessels under the action of light from a quartz mercury vapor lamp, copper arc or more slowly in sunlight." He also calls the attention to the fact that nitrification in the atmosphere and seasonal variations of the nitrate-nitrite contents in favor of the summer months can be successfully explained on the basis of the photochemical view. Fraps and Sterges (**10 b**) have shown that photonitrification is of little or no practical importance.

Two laboratory methods have been used for the study of nitrification: solution or sand method and the most used soil or tumbler method. Although various inorganic and organic nitrogenous sources have been used for such studies, ammonium sulphate and dried blood have been preferred. The solution or sand method supplies information as to the absence or presence of nitrifying bacteria, influence of stimulating substances present in the soil, etc. This method is limited to the use of nitrogenous inorganic sources; since organic materials produce soluble organic compounds and ammonia which are toxic to the nitrifying bacteria. The sensitivity is more pronounced to organic substances in solution than in soil.

It is of great importance in nitrificaton studies to control the concentration of the nitrogenous salt, the pH range, the time and temperature of incubation and the optimum content of soil moisture. The usual concentration recommended for ammonium sulphate is 30 milligrams of nitrogen per 100 grams dry soil in the presence or absence of 210 milligrams of calcium carbonate which is equivalent to an addition of the theoretical amount of base necessary for the complete neutralization of all the nitric and sulphuric acids formed from the complete oxidation of the nitrogen added. For nitrification of organic nitrogenous materials, 0.25 per cent of organic matter with a high nitrogen content (10–12 per cent), such as dried blood, or 0.5–1.0 per cent of organic materials of a low nitrogen content (cottonseed meal, soy-bean meal, alfalfa meal) should be employed. The usual incubation time and temperature is 30 days at 25–28° C. For the solution or sand method a temperature of 28 to 30° C, is recommended. The optimum amount of water used in the tumbler method is from 50 to 60 per cent saturation.

Conditions which tend to promote nitrate formation in the soil are: temperature of 27.5° C., an abundant supply of air (oxygen), proper moisture supply, a favorable reaction (pH greater than 4.6), presence of carbonates or other buffering agents and absence of large quantities of soluble organic matter and alkali salts in the soil. The nature of the crop and the season also influences the nitrate content of the soil.

Although a definite correlation between the nitrifying power of a soil and its crop productivity has been observed by various investigators, some others reported that there may or may not be a correlation, and that continuous cropping, especially without fertilization, reduces the nitrifying capacity of the soil. The subject is fully discussed by Waksman (**32, 33**). Such a correlation may be limited

by some factor other than the nitrogen supply, such as moisture, temperature, aeration.

Fraps and Sterges (10 a) summarize studies on low nitrification capacity of soils as follows: "Soils which do not nitrify ammonium sulphate may be caused to nitrify it by addition of cultures of actively nitrifying soil, of calcium carbonate, or of both nitrifying culture and calcium carbonate. Nitrifying organisms may remain in a dry soil for many years. Nitrites may be produced from ammonium sulphate when calcium carbonate is added, though few nitrates may be produced at the same time."

From the physiological point of view nitrates is no longer considered to be the only form in which nitrogen is absorbed by certain plants. Tiedjens and Robins (29) found that ammonium hydroxide was a much better source of nitrogen than either sulphate of ammonia or calcium nitrate for the tomato and soybean and that ammonia was no more toxic to plants than were nitrates. They further comment: "Pirschle grew wheat, oats, corn, tobacco, cucurbits, peas, beans, soybeans and rape with ammonium sulphate, ammonium chloride, potassium nitrate, and calcium nitrate. He found that in a neutral culture some plants produced as good growth with ammonia as with nitrate salts or even better, but that an acid and even slightly alkaline reaction, nitrates were superior in most cases. Shive and Stahl state that seedlings absorb more ammonia than nitrate nitrogen but that mature plants require more nitrate nitrogen." In a more recent publication, Tiedjens (30) discusses experimental evidence on factors affecting assimilation (synthesis to amino acids and other organic nitrogenous materials) of nitrogen.

Nitrification Studies With Tropical Soils

Antipov–Karataev (2) in nitrification studies with soil from the Nikita orchard, Crimea, found: "Intensity of nitrification in orchard soils is similar to that of fallow in the chernozem district. Tobacco and virgin soils give the same amount of nitrates as chernozem soils under corn or sorghum after a fallow. In the shaly soil, low in lime, the process of nitrification was slow. During the period of intensive growth of tobacco no accumulation of nitrates was noted."

Prescott (26) and Roche (28) studied nitrification of Egyptian soils. Prescott says: "Nitrification is well ahead of the needs of the cotton crop, and probably entirely accounts for the fact that nitrogenous fertilizers produce no effect on this crop. There is no accumulation of nitrates in the soil when wheat and maize are grown."

The work of Prescott also covers observations of seasonal variations of nitrates and pot experiments showing the effect of the growth of maize and wheat on the accumulation of nitrates. The work of Roche includes some observations of rate of nitrification in soils under irrigation.

Peck (23, 24) carried some nitrification experiments with soils of Hawaii, using the tumbler method. His results showed that blackstrap molasses from sugar cane removes temporarily part of the available nitrates. Nitrificaton of ammonium sulphate was checked and nitrification of nitrogenous organic fertilizers was retarded by adding molasses. Kelley (20) and Burgess (8) also studied nitrification in soils of Hawaii. Kelley found that nitrification was as active in the manganese and titanium soils as in other soils, but magnesium carbonate was especially toxic. Burgess reports the following data:

Productivity of Soil	Nitrifying power (Mgm. nitrogen per 100 gms. dry soil)	
	Dried blood	Alfalfa meal
Best	20.8	15.2
Very good	15.2 — 20.0	9.6 — 12.8
Poorer	4.0 — 13.6	7.2 — 9.0
Poorest	4.0	4.5

In 1927, Bal (4) found in a black soil in India, planted to cotton, that concentrations of over 100 milligrams of ammoniacal nitrogen from ammonium hydroxide are definitely injurious to the process of soil nitrification. Plymen and Bal (25) studied nitrification rates of different nitrogenous organic manures in some typical soils of Berar, India. Hutchinson (17) summarizes investigations on nitrification in India soils. Joshi (19) reports on rate of nitrification of different green manures and influence of crop residues on nitrification in India soils. Walton (35) studied the influence of alkali salts on nitrification in some India soils and also (34) the rate of nitrification of calcium cyanamide as compared with ammonium sulphate and mustard cake. Batham (5) compares nitrification rate of certain amino acids and ammonium sulphate in India soils.

Itano and Arakawa (18) report studies in the rice fields of Japan on relation of nitrification to crop yield of rice, seasonal variations and soil specific buffer capacity.

Wilcox (**37**) presents a soil nitrification map of the Bandjaratma concession of Java as prepared by Arrhenius who recommends, as sound soil management for a sugar-cane plantation, a map, to show the distribution of the soil's nitrifying power. Arrhenius correlated soil nitrifying power with sugar-cane yields and showed that soil reaction does not parallel nitrate production.

Gerretsen (**11**) in work with Java soils found that the concentration of ammonium salts through soil adsorption may be so high that nitrification becomes impossible. He claims that the intensity of nitrification in different soils does not necessarily have any direct effect on crop production, and its importance as an index of fertility has often been overrated, although the two frequently run parallel.

Pañganiban (**22**) reports nitrification studies, with ammonium sulphate and dried blood, in Philippine soils planted to yautias, corn, banana and cogon. Aquino and Javier (**3**) report nitrification studies in eighteen different soil types of the Philippine Islands, and Alicante (**1**) found: "Treatment of citrus soils constitute conclusive evidence that nitrification is an index of crop production. In general, soils devoted to sugar cane converted their original nitrogen into available form more slowly than did those devoted to rice, abacá, tobacco, citrus, etc. Soils containing a high percentage of clay nitrified either the original or the added nitrogen very poorly." He gives data on the average nitrifying power of some of the Philippine soils as compared to those of Hawaii and the United States.

Watt (**36**) studied nitrification in Transvaal soils. Martin and Massey (**21**) studied the effect of seasonal variation on the nitrification rate of Sudan soils. Hall (**14**) studied nitrification rate of some South African soils supplemented with additions of limestone, dried blood, dried cowpea hay, bone meal, ammonium sulphate, whale guano, calcium cyanamide, crayferine and sewage soil. He also studied seasonal variations of nitrates in virgin, cropped and cultivated lands and nitrate variation with soil depth. In further studies, Hall (**15**) studied nitrification in some acid soils of South Africa treated with superphosphate, and ammonium sulphate in the presence or absence of lime. He also reports nitrification data in tobacco soils.

Chardón (**9**) studied nitrification rate of dried blood in the presence or absence of calcium carbonate in an acid clay around the College of Agriculture at Mayagüez, Puerto Rico. Ramírez (**27**)

studied the rate of nitrification of filter press cake residue from a sugar-cane factory added to the red acid clay close to the Insular Experiment Station at Río Piedras, Puerto Rico. He found that nitrate nitrogen from the application to a soil of 15, 25 and 50 tons of filter press cake per acre begins to increase on the third month, goes to a maximum on the fifth month, then the tendency towards the sixth or seventh month is to decrease.

EXPERIMENTAL

Part 1 contains some of the unpublished research work done by the author in the New Jersey Agricultural Experiment Station, under the direction of the soil microbiologist, Dr. Selman A. Waksman, as contained in a thesis presented in partial fulfillment of the requirement for the degree of Master of Science. The main part of said thesis entitled "Nitrogen transformations in the decomposition of sugar-cane trash, with special bearing upon Puerto Rico soil problems" has been published (6) elsewhere. It also contains some essential data from that thesis reported in a published paper (7) entitled "Preliminary microbiological studies in certain soils of the San Juan area, Puerto Rico".

Part II contains the complete laboratory data of the work done from 1930–1934 in fulfillment of the requirements of a research project of the Insular Experiment Station entitled: "Nitrification studies for a typical soil type in each classified soil series in Puerto Rico." The limitations of our means allowed only to undertake studies with soils from the northern coast of Puerto Rico.

SOILS

The preliminary soil survey maps and reports which are a part of the Soil Survey of Puerto Rico as undertaken since 1928 by the United States Bureau of Chemistry and Soils in cooperation with the Insular Experiment Station were used as a basis for soil location, classification and description. The soil types were taken from a list, tentatively called "North Coast Area of Puerto Rico", which was correlated and approved by the Soil Survey Division of the United States Bureau of Chemistry and Soils on March 16, 1934.

Soil Types: The following soil types are included in these studies:

1. Catalina clay. This soil is a deeply weathered soil of the mountain and hill lands. It is derived from andesitic tuffs. The surface ranges from rolling to steep; however, most of the hills are

rounded with gently sloping ravines. It varies in color from light red to reddish-brown. This soil is well drained but is affected by sheet erosion. It has a friable clay surface whose depth varies with surface relief from about four to eight inches. The subsoil is a reddish-brown or light-red, slightly heavy, but friable clay. At a depth of about 24 inches the soil becomes a deep red clay which continues to great depths. This soil is usually acid. It is used for a variety of crops as cane, citrus, pineapples, coffee and minor crops; and produces profitable yields. This is one of the best coffee soils.

2. Catalina clay level phase. This is the Catalina clay with a nearly level to slightly undulating relief. It is more deeply weathered than the main type as it has not been affected by sheet erosion. Its surface soil is deeper. Farmers prefer it to the main type for most all crops. It is used mostly for cane, citrus and pineapples; all do very well on it.

3. Coto clay light textured phase. This type occurs on nearly level surface relief. It is characterized by a dark grayish-brown, permeable, friable clay about a foot thick underlain by a reddish-brown, slightly compact, permeable clay subsoil and a yellowish-brown, non-plastic clay lower subsoil which usually rests on hard limestone at about 6 feet, but may vary from 26 inches to 12 feet. It is just slightly acid. The most profitable crop adapted to this soil is sugar cane. Other crops producing a good profit are Spanish pepper, tomatoes, corn, ñames, cotton, beans and bananas.

4. Espinosa clay. This type is the acid counterpart of the Coto clay, but has a less yellowish subsoil more mottled in the lower subsoil. In many places the subsoil is quite red. It occurs on gently undulating surfaces in large and small valleys and generally in very well drained positions. It is characterized by a 10-inch surface horizon of light brown to reddish yellow somewhat stiff and finely cloddy clay upper subsoil, and 15 to 30 inches or more of reddish-yellow friable clay which is sometimes mottled red in the deeper horizons. Limestone, the original parent material, occurs at greatly varying depths. It is used almost entirely for sugar-cane production.

5. Lares clay loam. This soil belongs to a group of deeply weathered soils with medium friable subsoils that occur on terraces or on terrace-like positions, with level to slightly undulating relief. It is affected by gully erosion. It is characterized by a heavy clay loam surface with a brown to reddish-brown color that crushes fairly easily into granules and some rounded quartz grains. At a depth

of about 6 inches the soil changes to red or brownish red, heavy, medium plastic clay that cracks some on drying; in the lower part of this layer usually at a depth of only about 14 inches is mottled red and yellowish-medium friable clay. At about 40 inches is a friable red, yellow and brown clay that continues to great depth. In places it looks very much like disintegrated tuff. A characteristic feature of this soil is the noticeable amount of water rounded rocks on this soil and throughout the profile. Many of the rocks are flat and pitted. The rocks near the surface are coated with a layer about 1/16 of an inch thick, consisting of a dark mineral, like that composing the perdigon, although very few perdigons are noticed except where this soil grades into Sabana Seca. In the lower depths there will often be gravel layers resembling water deposited gravel. These rounded gravel are of shale, andesite and tuffs. This soil is acid in all layers. It has been influenced by materials from other soil series (Río Piedras and Cialitos). It is used mostly for sugar cane and citrus.

6. Múcara silty clay loam. This undulating to rolling hill soil is easily recognized by its brown surface and light-brown subsoil over a brown igneous rock. It is a medium weathered soil characterized by a dark brownish gray or grayish-brown, gritty silty clay loam surface that is stained lightly in the lower part with gray. This layer is underlain at a depth of about 9 inches by a yellowish, slightly plastic clay or clay loam that has grayish or rust colored mottles. In places small angular fragments of partly weathered rock material occur in this layer and in places the clay is moderately tough and compact. The lower subsoil is a yellowish, light textured, transitional layer consisting of gritty clay loam mixed with partly decomposed rocks. The depth to rock, depending upon the slope, varies from 14 inches to 3 feet. It is affected by sheet erosion. Sugar cane, beans, pigeon peas, corn, yautía, etc., are among the crops planted. Soil depth limits crop yields.

7. Múcara silt loam. This soil differs from the silty clay loam type in having a lighter texture surface and slightly less heavy subsoil.

8. Sabana Seca clay. This is a fertile soil but not very productive because of its heavy stiff subsoil that resists ready penetration of air, plant roots and water. It occurs on nearly level to undulating surface relief, is very acid, and is probably derived from marine deposits. It is characterized by a dark brown, medium compact clay

surface. At a depth of about 5 to 7 inches there is a thin sub-surface layer about 3 inches thick of light yellow, heavy, medium compact clay; this abruptly changes at about 10 inches to an extremely heavy, stiff, plastic, mottled red, rich brown, gray and yellow clay. This layer continues to a depth of about 30 inches where it becomes gradually lighter in texture and slightly less compact; however, at depths below six feet the soil is still heavy mottled and compact. Cane and pasture are the two best crops grown.

9. Toa silt loam. This is an alluvial, well drained, loose and porous soil developed from material washed from the shale and limestone hills. It is the best sugar-cane soil in the North Coast of Puerto Rico. It is characterized by a grayish-brown color, nearly uniform in both color and texture to a depth of several feet and has very little mottling in the subsoil.

Location of soil samples: The samples used in part I were taken to a depth of six inches with a shovel, from a single representative spot not under cultivation.

Soil Types Used in Part I	Location
Catalina clay level phase	Km. 2.25 sideroad from Trujillo Alto mainroad to Leper Colony.
Lares clay loam	Km. 2.2 Sanatorium road, Rio Piedras.
Múcara silty clay loam	Km. 2.8 Carolina-Juncos road.
Toa silt loam	Km. 10.3 San Juan-Bayamón road.

The next chart indicates the location of soil samples used in part II. Samples numbered 1–15 inclusive were taken also to a depth of six inches with a shovel in representative spots not under cultivation. Samples 16 and 17 were taken all over the field to a depth of twelve inches with a soil auger; since these samples were also used for other chemical work.

Sample Number	Date	Soil types used in part II	Location	Sampling places
1.........	August 5, 1930..	Lares clay loam ..	Km. 2.2 Sanatorium road............	1
2.........	August 5, 1930..	Lares clay loam .	Km. 2.0 Bayamón-Slaughterhouse road	1
3.........	August 5, 1930..	Lares clay loam..	Km. 2.8 Bayamón-Comerio road	1
4.........	March 11, 1931..	Toa silt loam.....	Julia farm close to Central Constancia, Toa Baja	6
5.........	March 5, 1931...	Toa silt loam.....	Central Canóvanas, opposite main office	3
6.........	March 11, 1931..	Toa silt loam.....	Nevares farm at km. 1.8 of side road to Central Constancia	6
7.........	March 11, 1931..	Toa silt loam.....	San Antonio farm at km. 10.3 San Juan-Bayamón road	6
8.........	March 5, 1931...	Toa silt loam.....	Tamarindo farm, at km. 26.6 Rio-Grande-Mameyes road	3
9.........	March 11, 1931..	Toa silt loam.....	El Naranjal farm, 1 km. N. Carolina	3
10.........	March 5, 1931...	Múcara silty clay loam	Km. 45 Luquillo-Fajardo road.......	3
11.	March 11, 1931..	Múcara silty clay loam	Km. 9.9 Guaynabo-La Muda road...	6
12.........	March 5, 1931...	Múcara silt loam.	La Carmen farm on El Verde side-road at km. 26.6 Río Grande-Mameyes road	3
13.........	April 27, 1930...	Coto clay-light texture phase	Km. 24 Quebradillas-Guajataca road	1
14.........	April 27, 1930...	Coto clay-light texture phase	Km. 8.5 Arecibo-Lares road	1
15.........	April 28, 1932...	Espinosa clay.....	Km. 68.8 Arecibo-Barceloneta........	1
16.........	Nov. 24, 1933...	Sabana Seca clay.	University farm Rio Piedras.........	About 30
17.........	August 20, 1933.	Catalina clay, sample A	Mr. Juan Esteva's farm, Lares......	23

Soil preparation: All samples in part I were sifted in the air-dried state through a 2 mm. sieve. All samples in part II were sifted in the fresh state.

Soil analysis and treatments: Moisture and soil total water holding capacity was then determined.

Soils were treated in duplicate according to the Waksman's (31) tumbler method, i.e.

"1. Nitrification of soil's own nitrogen. A definite amount of soil (100 gm.) kept in the laboratory for a definite length of time (30 days) at a definite temperature (25–28° C.), under optimum moisture conditions, will give us information on the forms of nitrogen present in the particular soil and the speed with which they are transformed into nitrates and thus made available for plant growth.

"2. Nitrification of ammonium sulphate in the soil. By using a definite amount of nitrogen 30 mgm. in 100 gm. of soil, in the form of ammonium sulphate, and standard period of incubation, we get, from the amount of nitrate formed, an index on the buffering capacity of the soil in relation to nitrification. The final reaction should always be recorded.

"3. Nitrification of ammonium sulphate in the presence of a theoretical amount of $CaCO_3$, 210 mgm. for 30 mgm. N as $(NH_4)_2SO_4$ necessary to neutralize all the acid formed from the complete oxidation of the ammonium sulphate into nitric and sulfuric acid. This gives an index of the nitrifying capacity of the soil under optimum reaction conditions and forms an excellent basis for comparing nitrification with other biological activities."

Nitrification of soil's own nitrogen in the presence of the theoretical amount of $CaCO_3$ (210 mgm. for 100 gms. dry soil), as used in the ammonium sulfate treatment, was also studied.

In all, but one of the experiments, 60 percent of the soil total water holding capacity was taken for optimum moisture condition. The moisture lost by evaporation during the incubation period of 30 days was replaced at intervals.

Nitrates and ammonia were determined after 15 and 30 days, respectively. In most of the samples those determinations were also made at the start. The usual pH determinations were made after the 30-day period. Some pH determinations were also run at the start.

The phenoldisulphonic colorimetric method was used for nitrates.

In part II, ammonia was determined by direct distillation with magnesia. In part I, ammonia was determined by the Harper's (16) modification which consists in extracting the ammonium ion in the soil with normal potassium chloride and then distilling with magnesia. The determinations for pH were made with the potentiometer using quinhydrone and a saturated calomel-potassium chloride electrode.

I. RESEARCH WORK DONE IN NEW JERSEY AGRICULTURAL EXPERIMENT STATION

The soil type, Sassafras sandy loam, sampled on June 24th, 1929, from the experimental plots of the New Jersey Agricultural Experiment Station at New Bunswick was used as a basis for comparison.

Nitrification Studies of Puerto Rico Soils at 25 per cent Moisture Content

A twenty-five percent moisture content was chosen because it represents optimum moisture conditions for the Sassafras sandy loam. This is a productive soil derived from the unconsolidated sands and clays of the coastal plain.

TABLE I

NITRIFICATION RATE AT TWENTY-FIVE PER CENT MOISTURE
UNTREATED SOIL

Soils	pH		Mgm. of Nitrogen per 100 gms. dry soil as:			
			Nitrate		Ammonia	
	Start	30 da.	Start	30 da.	Start	30 da.
Toa silt loam	5.8	6.0	5.9	7.4	1.1	3.4
Catalina clay level phase	6.7	6.6	5.7	5.7	1.4	6.8
Lares clay loam	4.7	4.6	2.4	2.7	0.9	4.9
Múcara silty clay loam	6.8	6.1	4.8	9.2	1.6	Trace
Sassafras sandy loam	5.7	5.9	6.3	6.5	Trace	Trace

SOIL + 30 mgm. OF NITROGEN AS $(NH_4)_2SO_4$ + $CaCO_3$ (210 mgm.)

Soils	pH	Mgm. of Nitrogen per 100 gms. dry soil as.							
		Nitrate				Ammonia			
	30 da.	Start	7 da.	14 da.	30 da.	Start	7 da.	14 da.	30 da.
Toa silt loam	7.1	5.9	6.7	8.3	9.4	31.1	20.3	18.7	15.1
Catalina clay level phase	7.4	5.7	6.1	6.0	5.3	31.4	32.2	33 1	33.6
Lares clay loam	5.4	2.4	2.6	2.9	2.7	30.9	31.3	31.7	30.5
Múcara silty clay loam	7.0	4.8	7.1	9.9	11.7	31.6	25.7	24.6	20.3
Sassafras sandy loam	5.4	6.3	14.6	22.2	30.0	30.5	19.8	11.0	2.4

Under the conditions of that experiment there was no nitrate accumulation from the soil's own nitrogen sources in, and from the ammonium sulfate added to, the soil types from Puerto Rico known as Catalina clay level phase and Lares clay loam, although those soils had sufficient ammonia to start the nitrification processes.

In the other soils, the rate of nitrate accumulation goes hand to hand with ammonia disappearance.

The soil from New Jersey had a higher nitrifying rate; but we must consider that the 25 percent moisture content was probably not the optimum one for the two soils from Puerto Rico.

At the start, the pH of all the soils was in the acid range. Even with the addition of the calcium carbonate, the Lares clay loam had a pH of 5.4, after the 30-day period. The New Jersey soil had that same pH, but its nitrification rate was quite active. The pH for the other soils, at the end of the 30-day period was close to the neutral point, in the alkaline side.

Influence of Lime and Inoculation upon Nitrification in Two Puerto Rico Soils

In an attempt to find the limiting factor responsible for checking nitrification in the Catalina clay level phase and Lares clay loam, these soils were treated as before; but this time, 500 milligrams of calcium carbonate were added, and treatments also included inoculation of the soils with one cubic centimeter of a 10 percent water infusion of the Sassafras sandy loam. All the soils were kept at a 25 percent moisture content.

TABLE 2

EFFECT OF LIME AND INOCULATION UPON NITRIFICATION RATE OF CATALINA CLAY LEVEL PHASE AND LARES CLAY LOAM

Treatment	pH	Mgm. of Nitrogen per 100 grams of dry soil			
		As Nitrate		As Ammonia	
	30 da.	Start	30 da.	Start	30 da.
Catalina clay level phase	6.0	5.7	6.4	1.4	7.6
Catalina clay level phase + $(NH_4)_2SO_4$ (30 mgm. N.)	6.8	5.7	7.2	31.4	37.5
Catalina clay level phase + $(NH_4)_2SO_4$ + $CaCO_3$ (500 mgm.)	7.9	5.7	5.2	31.4	34.6
Catalina clay level phase + $(NH_4)_2SO_4$. Inoculated	6.8	5.7	10.0	31.4	36.1
Catalina clay level phase + $(NH_4)_2SO_4$ + $CaCO_3$. Inoculated	7.9	5.7	4.8	31.4	31.7
Lares clay loam	5.1	2.4	2.8	.9	2.2
Lares clay loam + $(NH_4)_2SO_4$ (30 mgm. N.)	5.1	2.4	3.0	30.9	34.6
Lares clay loam + $(NH_4)_2SO_4$ + $CaCO_3$ (500 mgm.)	7.8	2.4	2.2	30.9	34.6
Lares clay loam + $(NH_4)_2SO_4$. Inoculated	5.1	2.4	2.2	30.9	36.1
Lares clay loam + $(NH_4)_2SO_4$ + $CaCO_3$. Inoculated	7.8	2.4	2 6	30.9	35.3

The Lares clay loam did not show nitrate accumulation in any of the different treatments. Reaction was not the limiting factor; since the calcium carbonate added, was enough to bring the pH towards the alkaline side.

The addition of lime did not favor nitrate accumulation in the Catalina clay level phase. Perhaps the alkalinity (pH 7.9) did not favor the activity of the nitrifying organisms. That same activity

was checked at (pH 7.4) in the previous experiment. Where ammonium sulfate was added alone there was a slight accumulation of nitrates, more so, in the inoculated soil. The reaction in those cases was (pH 6.8). Alkaline reactions or the presence of an excess of calcium ions have limiting effects on the activity of the nitrifying organisms in this soil. The next experiment will help to clear these points and indicate whether the effect of inoculation on nitrate accumulation may be considered as significant.

Nitrification Studies of Puerto Rico Soils at Optimum Moisture

To favor conditions for the activity of the nitrifying organisms the Puerto Rico soils were brought to optimum moisture at 60 percent of the total water holding capacity. This work has been reported elsewhere (8). (In that paper the soil type reported as Río Piedras clay should be Catalina clay level phase; the Bayamón clay loam should be Lares clay loam, and the Múcara clay should be Múcara silty clay loam.) The rate of nitrification of dried blood was also studied. The amount added was 250 milligrams containing 32 milligrams of nitrogen. The calcium carbonate added was 500 milligrams.

TABLE III

NITRIFICATION RATE OF SOILS AT OPTIMUM MOISTURE

(MGM. N PER 100 GMS. DRY SOIL)

Treatments	Catalina clay level phase					Lares clay loam				
	pH	Nitrate			Amm.	pH	Nitrate			Amm.
	30 da.	Start	15 da.	30 da.	30 da.	30 da.	Start	15 da.	30 da.	30 da.
Soil alone	6.5	5.7	5.5	5.5	8.6	5.0	2.4	1.6	1.8	7.6
Soil + $CaCO_3$ (500 mgm.)	7.2	....	5.2	5.0	5.7	7.1	....	1.9	2.2	9.4
Soil + dried blood (32 mgm. N)	6.6	....	3.8	5.0	27.4	5.3	....	3.0	3.4	24.9
Soil + $(NH_4)_2SO_4$ (30 mgm. N)	6.4	....	5.2	5.7	35.3	4.6	....	1.8	1.7	33.8
Soil + $(NH_4)_2SO_4$ + $CaCO_3$	6.4	....	4.8	10.6	13.3	7.0	....	1.8	1.5	34.6

TABLE III

NITRIFICATION RATE OF SOILS AT OPTIMUM MOISTURE

(MGM. N PER 100 GMS. DRY SOIL)

Treatments	Múcara silty clay loam					Toa silt loam				
	pH	Nitrate			Amm.	pH	Nitrate			Amm.
	30 da.	Start	15 da.	30 da.	30 da.	30 da.	Start	15 da.	30 da.	30 da.
Soil alone	6.3	4.8	8.0	12.3	2.2	6.6	5.9	6.1	7.3	6.5
Soil + $CaCO_3$ (500 mgm.)	7.4	....	8.0	13.3	2.2	7.6	....	7.0	10.7	1.5
Soil + dried blood (32 mgm. N)	6.5	....	8.0	13.3	18.0	6.9	....	7.0	8.6	18.0
Soil + $(NH_4)_2SO_4$ (30 mgm. N)	6.0	....	6.7	12.0	25.2	6.3	....	5.6	6.1	23.7
Soil + $(NH_4)_2SO_4$ + $CaCO_3$	7.1	....	7.3	27.9	8.6	7.1	....	8.0	19.4	9.4

The rate of nitrification of the soil's own nitrogen under optimum conditions was almost identical to that under the 25 percent moisture content reported in Table I. All soils were able to ammonify dried blood. The accumulation of nitrates from dried blood was only evident in the Múcara silty clay loam and Toa silt loam.

Let us compare now the nitrification rate of ammonium sulfate in the presence of lime, under these conditions, with that of the Sassafras sandy loam reported in Table I.

Soil Type	Optimum moisture %	pH		Milligrams of Nitrogen per 100 gms. dry soil as:				
				Nitrate			Ammonia	
		Start	30 da.	Start	15 da.	30 da.	Start	30 da.
Lares clay loam	32.8	4.7	7.0	2.4	1.8	1.5	30.9	34.6
Catalina clay level phase	40.0	6.7	6.4	5.7	4.8	10.6	31.4	13.3
Toa silt loam	40.0	5.8	7.1	5.9	8.0	19.4	31.1	9.4
Múcara silty clay loam	36.0	6.8	7.1	4.8	7.3	27.9	31.6	8.6
Sassafras sandy loam	25.0	5.7	5.4	6.3	22.2	30.0	30.5	2.4

Optimum moisture and pH conditions did not favor nitrification in the Lares clay loam; but were effective in showing that the Catalina clay level phase contains active nitrifying organisms able to convert ammonium sulfate into nitrates and that the organisms were not affected by excess of calcium ions.

The rate of nitrification after the 15-day period, for the Puerto Rico soils, is identical with 25 percent and optimum moisture contents. Striking difference is observed after the 30-day period. The nitrification rate was favored in all soils; but the Lares clay loam. Taking the rate of nitrification on the New Jersey soil as 100 percent, the nitrifying Puerto Rico soils, at the end of the 30-day period, compare as follows:

	Percentage
Múcara silty clay loam	99.67
Toa silt loam	64.67
Catalina clay level phase	35.33

II. RESEARCH WORK DONE IN THE INSULAR STATION OF PUERTO RICO

Nitrification studies were continued in Puerto Rico, with new samples of soils sifted in the fresh state.

Further Nitrification Studies with Lares clay loam at Optimum Moisture Conditions

As the previous experiments indicated lack of nitrate accumulation in the Lares clay loam, three fresh soil samples were taken from different places. Sample #2 was taken from the same place as that one used in New Jersey. Nitrification of ammonium dibasic phosphate was also studied. The optimum moisture for samples #1 and #2 were 45 and 36 percent, respectively.

TABLE IV (a)

NITRIFICATION RATE OF LARES CLAY LOAM

(MGM. N PER 100 GMS. DRY SOIL)

Tumbler No.	Tratments	Sample (No. 1)						Sample (No. 2)					
		pH	Nitrate			Ammonia		pH	Nitrate		Ammonia		
		30 da.	Start	15 da.	30 da.	15 da.	30 da.	30 da.	Start	15 da.	30 da.	15 da.	30 da.
1.......	Soil.......................	4.6	.8	1.7	2.5	5.5	5.5	4.9	Tr.	1.3	2.3	7.6	5.6
2.......	Soil + $CaCO_3$ (210 mgm.)	5.9	.....	3.1	5.5	7.6	11.1	5.9	.....	1.6	3.1	8.8	7.6
3.......	Soil + $(NH_4)_2SO_4$ (30 mgm. N)..............	4.7	.....	1.9	2.5	38.5	39.9	4.9	.....	1.8	1.5	36.4	35.8
4.......	Soil + $(NH_4)_2SO_4$ + $CaCO_3$ (210 mgm.).....	5.0	.....	4.1	8.6	37.1	33.0	6.0	.....	1.7	2.9	35.7	35.8
5.......	Soil + $(NH_4)_2SO_4$ + $CaCO_3$ (360 mgm.).....	5.3	.....	18.3	23.9	23.4	15.1	6.3	.....	1.4	5.4	38.5	33.0
6.......	Soil + $(NH_4)_2HPO_4$ (30 mgm. N)..............	5.0	.....	2.2	3.4	35.8	37.3	5.1	.....	1.8	2.5	32.3	33.0
7.......	Soil + $(NH_4)_2HPO_4$ + $CaCO_3$ (210 mgm)......	4.7	.....	8.3	20.3	24.8	22.0	5.8	.....	2.2	3.8	33.0	30.4

Both ammonium salts added to sample #1 are able to nitrify in the presence of lime. The higher amount of lime (360 mgm.) favored nitrification of ammonium sulfate in both samples, but in sample #2 the nitrification rate was quite low. Please recall that this fresh sample was taken from the same place as that one used in New Jersey.

It was decided to study nitrification rate of the same ammonium sulfate up to a 60-day incubation period. The moist soils left after the 30-day period in treatments 3, 4 and 5 of sample #2 were modified, as shown below, either by adding more calcium carbonate or

potassium chloride. The amounts added are in terms of 100 grams dry soil. A and B are duplicates from the 30-day period treated differently. Sample 5A was left as the check.

TABLE IV (b)

EFFECT OF THE EXTENSION OF THE INCUBATION PERIOD AND PRESENCE OF POTASH AND MORE LIME ON THE NITRIFICATION RATE OF A POOR NITRIFYING, LARES CLAYLOAM

Tumber No.	Treatment given to sample (No. 2) after the 30 day period	pH		Mgm. N per 100 gms. dry soil as: Nitrate		Ammonia	
		30 da.	60 da.	30 da.	60 da.	30 da.	60 da.
3A.........	Soil + $(NH_4)_2SO_4$ + $CaCO_3$ (500 mgm.).......	4.9	7.1	1.5	4.4	35.8	39.5
3B.........	Soil + $(NH_4)_2SO_4$ + $CaCO_3$ (750 mgm.).......	4.9	7.2	1.5	3.9	35.8	43.7
4A.........	Same as 3A......................................	6.0	6.8	2.9	7.7	35.8	31.5
4B.........	Same as 3A + K_2O (30 mgm.)..................	6.0	6.7	2.9	6.9	35.8	31.5
5A.........	CHECK: Soil + $(NH_4)_2SO_4$ + $CaCO_3$ (360 mgm.)..	6.3	6.1	5.4	8.7	33.0	18.7
5B.........	Soil + $(NH_4)_2SO_4$ + $CaCO_3$ (500 mgm.) + K_2O (100 mgm.)..................................	6.3	6.4	5.4	13.3	33.0	14.3

Results indicate that the rate of ammonium sulfate nitrification of Lares clay loam is limited by the length of the incubation period and the absence of lime and potash.

Nitrification rate of ammonium sulfate and ammonium dibasic phosphate in Lares clay loam

Nitrification rate of ammonium sulfate and ammonium dibasic phosphate in the presence of more lime and potash was studied in sample #2 of Lares clay loam which showed slight evidence of nitrification after the 30-day period.

TABLE V

NITRIFICATION RATE OF AMMONIUM SULFATE AND AMMONIUM DIBASIC PHOSPHATE IN A POOR-NITRIFYING LARES CLAY LOAM

Treatment given to Lares clay loam Sample No. (2)	pH	Mgm. N per 100 gms. dry dry soil as:			
		Nitrate		Ammonia	
	30 da.	15 da.	30 da.	15 da.	30 da.
Soil + $(NH_4)_2SO_4$ (30 mgm. N) + $CaCO_3$ (500 mgm.)..	6.7	.5	2.2	48.6	41.3
Soil + $(NH_4)_2SO_4$ + $CaCO_3$ + K_2SO_4 (100 mgm. K_2O)..	6.4	.6	1.7	44.9	44.1
Soil + $(NH_4)_2HPO_4$ (30 mgm. N) + $CaCO_3$ (500 mgm.)...	6.3	.9	7.4	40.2	29.4
Soil + $(NH_4)_2HPO_4$ + $CaCO_3$ + K_2SO_4 (100 mgm. K_2O).	6.3	.7	7.1	39.8	37.0

Dibasic ammonium phosphate nitrifies in the presence of 500 milligrams of calcium carbonate without the influence of potash. The ammonium sulfate showed a very slight tendency to nitrify in the presence of sufficient lime and potash. It seems therefore, that the presence of the phosphate ion in the presence of sufficient lime favors the nitrification process in this soil.

Nitrification studies in another sample of Lares clay loam

Nitrification studies of ammonium sulfate and ammonium dibasic phosphate were made in a sample of Lares clay loam from a different location. The treatments given are shown in Table VI.

TABLE VI.

NITRIFICATION RATE OF ANOTHER SAMPLE OF LARES CLAY LOAM

Treatments given to Sample (No. 3). Optimum moisture-30%	pH	Mgm. N. per 100 gms. dry soil as				
		Nitrate			Ammonia	
	30 da.	Start	15 da.	30 da.	15 da.	30 da.
Soil	5.6	Tr....	1.7	2.4	9.9	8.9
Soil + $CaCO_3$ (360 mgm.)	7.1	....	7.7	6.7	7.1	8.1
Soil + $(NH_4)_2SO_4$ (30 mgm. N)	5.5	....	1.3	2.0	40.1	39.5
Soil + $(NH_4)_2SO_4$ + $CaCO_3$ (360 mgm.)	5.3	....	25.0	19.3	11.5	7.2
Soil + $(NH_4)_2SO_4$ + $CaCO_3$ (500 mgm.)	6.4	....	13.8	36.4	9 9	3.6
Soil + $(NH_4)_2HPO_4$ (30 mgm. N) + $CaCO_3$ (360 mgm.)	6.0	....	13.8	36.4	7.8	2.9
Preceding treatment + KCl (100 mgm. K_2O)	5.7	....	8.5	19.3	16.5	7.2

The amount of lime was a dominant factor in the nitrification of both ammonium salts. The ammonium sulfate maximum nitrification was obtained with 500 milligrams of calcium carbonate. That same maximum nitrification was obtained with the ammonium dibasic phosphate; but in the presence of less lime (360 mgm. $CaCO_3$). The potash had no effect.

NITRIFICATION STUDIES IN SIX SAMPLES OF TOA SILT LOAM

Sample Number	Location	Optimum moisture (60% of total water holding capacity
4	Central Constancia, Toa Baja	47.70
5	Central Canóvanas	35.40
6	Nevares farm, Toa Baja	40.20
7	San Antonio farm, Bayamón	43.80
8	Tamarindo farm, Río Grande	39.90
9	El Naranjal farm, Carolina	36.00

TABLE VII

NITRIFICATION RATE OF TOA SILT LOAM

(MGM .N PER 100 GMS. DRY SOIL)

Treatments	Soil Number (4)							Soil Number (5)							Soil Number (6)						
	pH		Nitrate			Ammonia		pH		Nitrate			Ammonia		pH		Nitrate			Ammonia	
	Start	30 da.	Start	15 da.	30 da.	15 da.	30 da.	Start	30 da.	Start	15 da.	30 da.	15 da.	30 da.	Start	30 da.	Start	15 da.	30 da.	15 da.	30 da.
Soil	6.3	6.2	N.D*	2.5	4.5	5.2	6.6	5.8	5.2	.4	2.7	3.1	7.4	6.6	5.7	5.7	N.D*	4.0	4.9	7.4	7.4
Soil + $CaCO_3$ (210 mgm.)	......	6.7	......	4.3	4.7	9.5	8.1	......	5.9	......	2.9	3.8	6.6	5.9	......	6.1	......	4.8	5.9	7.4	5.9
Soil + $(NH_4)_2SO_4$ (30 mgm. N)	......	5.5	......	23.5	26.7	11.1	5.9	......	4.8	......	5.3	10.8	23.5	18.3	......	6.5	......	15.4	15.4	15.4	11.1
Soil + $(NH_4)_2SO_4$ + $CaCO_3$	......	5.9	......	28.8	26.7	6.6	7.4	......	5.1	......	18.2	21.6	14.0	8.1	......	5.7	......	34.8	23.5	4.2	4.5

TABLE VII

NITRIFICATION RATE OF TOA SILT LOAM

(MGM .N PER 100 GMS. DRY SOIL)

Treatments	Soil Number (7)							Soil Number (8)							Soil Number (9)						
	pH		Nitrate			Ammonia		pH		Nizrate			Ammonia		pH		Nitrate			Ammonia	
	Start	30 da.	Start	15 da.	30 da.	15 da.	30 da.	Start	30 da.	Start	15 da.	30 da.	15 da.	30 da.	Start	30 da.	Start	15 da.	30 da.	15 da.	30 da.
Soil	6.1	5.7	4.8	4.5	4.9	5.9	7.4	5.6	5.3	.4	4.8	7.4	5.2	5.9	7.1	6.2	.4	3.6	2.9	2.9	5.2
Soil + $CaCO_3$ (210 mgm.)	......	6.4	......	4.1	4.9	8.0	7.4	......	6.3	......	6.2	6.3	5.9	6.6	......	6.6	......	3.9	3.8	7.4	5.2
Soil + $(NH_4)_2SO_4$ (30 mgm. N)	......	5.4	......	6.6	10.3	24.4	19.9	......	5.2	......	6.8	8.3	39.1	25.8	......	5.8	......	4.8	8.7	25.8	21.4
Soil + $(NH_4)_2SO_4$ + $CaCO_3$	......	5.5	......	12.5	21.1	22.1	6.7	......	5.4	......	8.7	14.8	23.5	11.8	......	6.0	......	14.8	23.5	10.4	6.6

*N. D.—Not determined.

TABLE X

NITRIFICATION RATE OF ESPINOSA CLAY

(MMG. N PER 100 GMS. DRY SOIL.)

Treatments	pH		Nitrate			Ammonia	
	Start	30 da.	Start	15 da.	30 da.	15 da.	30 da.
Soil	6.6	5.8	5.6	6.3	8.8	13.6	13.6
Soil + $CaCO_3$ (210 mgm.)		5.9	....	6.6	8.9	14.8	14.8
Soil + $(NH_4)_2SO_4$ (30 mgm. N)		5.6	....	6.6	14.0	37.9	25.8
Soil + $(NH_4)_2SO_4$ + $CaCO_3$		5.5	......	11.1	17.4	18.3	13.6

The Coto and Espinosa soils are able to nitrify the ammonium sulfate in the absence of lime.

NITRIFICATION STUDIES IN SABANA SECA CLAY AND CATALINA CLAY

Sample Number	Soil Type	Location	Optimum moisture (60% of total water holding capacity
16	Sabana Seca Clay	Rio Piedras	27.6
17	Catalina Clay Plot (A)	Lares	39.0

TABLE XI

NITRIFICATION RATE OF SABANA SECA CLAY

Treatments	pH		Mgm. N per 100 gms. dry soil as:			
			Nitrate		Ammonia	
	Start	30 da.	15 da.	30 da.	15 da.	30 da.
Soil	5.4	5.3	.7	3.3	9.1	5.0
Soil + $CaCO_3$ (210 mgm.)	....	6.5	1.2	5.4	9.8	5.0
Soil + $(NH_4)_2SO_4$ (30 mgm. N)	....	5.3	.7	3.6	40.0	38.8
Soil + $(NH_4)_2SO_4$ + $CaCO_3$	....	5.8	.6	8.3	41.4	28.7

TABLE XII

NITRIFICATION RATE OF CATALINA CLAY

(MGM. N PER 100 GMS. DRY SOIL)

Treatments	pH		Nitrate		Ammonia	
	Start	30 da.	15 da.	30 da.	15 da.	30 da.
Soil	4.6	4.8	.9	.9	9.1	10.5
Soil + $CaCO_3$ (210 mgm.)	....	5.1	.8	1.3	9.8	11.1
Soil + $(NH_4)_2SO_4$ (30 mgm. N)	....	4.7	.7	.9	40.3	40.9
Soil + $(NH_4)_2SO_4$ + $CaCO_3$	....	5.1	.7	1.1	43.5	45.5

Lime helps the nitrification process of the Sabana Seca clay.

The treatments given to the Catalina clay were not effective in starting the nitrification process. The amount of lime added (210 mgm. $CaCO_3$) was not enough to correct the excess acidity of this soil.

GENERAL DISCUSSION

Let us now compare in table XIII the nitrification rate, at the end of the thirty-day period, of all the soils worked out, under similar conditions, in the preceding experiments.

Table XIII gives valuable information on the relation of soil pH to nitrate and ammonia accumulation. It also compares the nitrification and ammonification rate of the different soil types and the extent of variation of such processes within various samples of the same soil type. It offers valuable information as to whether ammonium sulfate should be used as source of nitrate for plant assimilation and whether it should prove advisable to lime the soil in order to hasten the nitrifying rate of ammonium sulfate or to use nitrate salts as a source of nitrogen.

Results indicate that ammonium sulfate should not be used as a source of nitrate for plants in the Lares clay loam, Sabana Seca clay and Catalina clay, and in some of the Múcara silty clay loam, unless special attention is given to lime broadcasting. The lime might be partially beneficial in the Lares clay loam and Catalina clay. It should also prove advisable, in those soils and in Sabana Seca clay, to apply part of the nitrogen as nitrate salts, preferably calcium nitrate.

Ammonium sulfate nitrifies quite well in the Toa silt loam, Coto clay light texture phase and Espinosa clay, even in the absence of lime. The application of ammonium sulfate as a source of nitrate

TABLE XIII

COMPARISON OF NITRIFICATION RATE OF SOME PUERTO RICO SOILS AND A NEW JERSEY SOIL AT OPTIMUM MOISTURE ON THE BASIS OF NITRIFICATION RATE AFTER THIRTY DAY PERIOD

(MGM. N. PER 100 gms. DRY SOIL)

Sample No.	Soil Type	Soil's own nitrogen				Ammonium sulfate (30 mgm. N)				Ammonium sulfate* (30 mgm. N) and $CaCO_3$ (210 mgm.)			
		pH	Nitrate	Ammonia	Total N *	pH	Nitrate	Ammonia	Total N *	pH	Nitrate	Ammonia	Total N *
1........	Lares clay loam............	4.6	2.5	5.5	8.0	4.7	2.5	39.9	42.4	5.0	8.6	33.0	41.6
2........	Lares clay loam............	4.9	2.3	5.6	7.9	4.9	1.5	35.8	37.3	6.0	2.9	35.8	38.7
Ave.......	**Lares clay loam...........**	**4.8**	**2.4**	**5.6**	**8.0**	**4.8**	**2.0**	**37.9**	**39.9**	**5.5**	**5.8**	**34.4**	**40.2**
4........	Toa silt loam..............	6.2	4.5	6.6	11.1	5.5	26.7	5.9	32.6	5.9	26.7	7.4	34.1
5........	Toa silt loam..............	5.2	3.1	6.6	9.7	4.8	10.8	18.3	29.1	5.1	21.6	8.1	29.7
6........	Toa silt loam..............	5.7	4.9	7.4	12.3	6.5	15.4	11.1	26.5	5.7	23.5	4.5	28.0
7........	Toa silt loam..............	5.7	4.9	7.4	12.3	5.4	10.3	19.9	30.2	5.5	21.1	6.7	27.8
8........	Toa silt loam..............	5.3	7.4	5.9	13.3	5.2	8.3	25.8	34.1	5.4	14.8	11.8	26.6
9........	Toa silt loam..............	6.2	2.9	5.2	8.1	5.8	8.7	21.4	30.1	6.0	23.5	6.6	30.1
Ave.......	**Toa silt loam..............**	**5.7**	**4.6**	**6.5**	**11.1**	**5.5**	**13.4**	**17.1**	**30.5**	**5.6**	**21.9**	**7.5**	**29.4**
10........	Múcara silty clay loam.....	6.7	11.8	4.5	16.3	6.7	24.7	3.6	28.3	7.0	25.7	2.9	28.6
11........	Múcara silty clay loam.....	6.1	1.3	8.1	9.4	5.4	1.0	35.6	36.6	5.3	18.5	12.6	31.1
Ave.......	**Múcara silty clay loam......**	**6.4**	**6.6**	**6.3**	**12.9**	**6.1**	**12.9**	**19.6**	**32.5**	**6.2**	**22.1**	**7.8**	**29.6**
12........	Múcara silt loam...........	5.5	17.2	4.5	21.7	5.8	16.3	28.1	44.4	5.8	27.8	5.9	33.7
13........	Coto clay light texture phase	5.6	5.8	12.8	18.6	5.4	22.2	26.3	48.5	5.2	36.4	12.9	39.3
14........	Coto clay light texture phase	5.7	3.6	12.1	15.7	5.3	40.0	13.6	53.6	5.2	40.0	12.2	52.2
Ave.......	**Coto clay light texture phase.....................**	**5.7**	**4.7**	**12.5**	**17.2**	**5.4**	**31.1**	**20.0**	**51.1**	**5.2**	**38.2**	**12.6**	**50.8**
15........	Espinosa clay..............	5.8	8.8	13.6	22.4	5.6	14.0	25.8	39.8	5.5	17.4	13.6	31.0
16........	Sabana Seca clay...........	5.3	3.3	5.0	8.3	5.3	3.6	38.8	42.4	5.8	8.3	28.7	37.0
17........	Catalina clay..............	4.8	.9	10.5	11.4	4.7	.9	40.9	41.8	5.1	1.1	45.5	46.6
	Sassafras sandy loam, New Jersey.....................	5.9	6.5	Trace	6.5	......	......	......	......	5.4	30.0	2.4	32.4

* Total N is the sum of nitrate and ammonia.

for plant growth should prove beneficial in those soils without considering the practice of lime broadcasting.

The thirty milligrams of nitrogen added as ammonium sulfate was accounted for, as nitrate and ammonia in all the soils. The slight excess of total nitrogen found in some cases, was due to the formation of ammonia by those active soil organisms able to decompose the soil's own protein material.

Let us now compare the average results given in Table XIII on a percentage basis. The results obtained with the Toa silt loam were taken as a basis for the comparison, since that alluvial soil is the most valuable and productive in the northern coast of Puerto Rico.

TABLE XIV

COMPARISON OF NITRIFICATION RATE ON AVERAGE BASIS

Soil Types	Thirty Day Nitrifying Period					
	Soil's own nitrogen		Ammonium sulfate (30 mgm. N)		Ammonium sulfate + $CaCO_3$ (210 mgm.)	
	Nitrate (Mgm. N)	Percent	Nitrate (Mgm. N)	Percent	Nitrate (Mgm. N)	Percent
Toa silt loam	4.6	100	13.4	100	21.9	100
Lares clay loam	2.4	52	2.0	15	5.8	26
Múcara silty clay loam	6.6	143	12.9	96	22.1	101
Múcara silt loam	17.2	374	16.3	122	27.8	127
Coto clay light texture phase	4.7	102	31.1	232	38.2	175
Espinosa clay	8.8	191	14.0	104	17.4	79
Sabana Seca clay	3.3	72	3.6	27	8.3	38
Catalina clay	.9	20	.9	7	1.1	5
Sassafras sandy loam	6.5	141	....	....	30.0	137

SUMMARY

Experimental results have been reported on the nitrification rate of nine soil types from Northern Puerto Rico classified as: Catalina clay, Catalina clay level phase, Coto clay light texture phase, Espinosa clay, Lares clay loam, Múcara silty clay loam, Múcara silt loam, Sabana Seca clay and Toa silt loam. The various soil types are represented by twenty-one different soil samples. Some experimental data is also reported for a soil type from New Jersey classified as Sassafras sandy loam.

The main object of the work was to establish a correlation on the following bases:

1. Nitrification of soil's own nitrogen.
2. Nitrification of soil's own nitrogen as affected by the addition of lime.
3. Nitrification of ammonium sulfate in the soil.
4. Nitrification of ammonium sulfate as affected by the addition of lime.

Studies were also carried with various samples of the same soil type in order to study the nitrifying range within the soil type.

All soils were similarly treated with respect to incubation period, temperature, and time; optimum moisture conditions; and concentration of lime and ammonium sulfate added to the soil.

The soil types known as Catalina clay level phase and Lares clay loam which showed a slight response to the above general treatments were also studied with respect to the influence of more lime and inoculation upon nitrification. One soil sample of Lares clay loam which also showed a slight response to inoculation and extra lime addition was also studied with respect to the effect of the extension of the incubation period and addition of potash in the presence of various amounts of lime. The nitrification rate of ammonium sulfate and ammonium dibasic phosphate was also compared in that soil.

Table XIII summarizes the experimental results comparing the nitrification and ammonification rate of the different soil types similarly treated and the variations of such a rate within various samples of the same soil type. Those results should prove of value in the practical application of ammonium sulfate as a fertilizer and indicate if it is advisable to lime the soil in order to hasten the nitrification rate of ammonium sulfate or to apply part of the nitrogen in the form of nitrate salts.

Table XIV contains data on the comparison of the nitrification rate of the various soils treated on a percentage basis. The most productive and valuable alluvial soil type of the north coast of Puerto Rico, Toa silt loam, was taken as the unit basis.

Conclusions

1. Ammonium sulfate should not be used as a source of nitrate for plants in the Lares clay loam, Sabana Seca clay and Catalina clay, and in some fields of Múcara silty clay loam, unless special attention is given to lime broadcasting. It should be more advisable to apply ammonium dibasic phosphate instead of ammonium sulfate to Lares clay loam, after special attention is given to lime broad-

casting. Although the lime might be beneficial in the Lares clay loam and Catalina clay, it should also prove advisable, in those soils, and in Sabana Seca clay, to apply part of the nitrogen as nitrate salts, preferably calcium nitrate.

2. Ammonium sulfate nitrifies quite well in the Toa silt loam, Coto clay light texture phase, and Espinosa clay, even in the absence of lime. The application of ammonium sulfate as a source of nitrate for plant growth should prove beneficial in those soils without considering of upmost importance the practice of lime broadcasting.

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HEAT STERILIZATION OF MANGOES AND GUAVAS FOR FRUIT FLIES

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Some mango varieties and apparently all guavas in Puerto Rico are infested by fruit flies and thus all mango and guava varieties are excluded from exportation to the United States. There is practically no demand for guava fruits, but the present limited demand for mangoes would probably increase as that fruit became better known.

Mangoes and guavas are excluded under quarantine regulation No. 58 established in 1925 on the basis of infestation by the West Indian fruit fly, *Anastrepha fraterculus* Wiedeman.

According to Greene (1), *A. fraterculus* Wied., does not occur in Puerto Rico. In the opinion of the writer (2), a variety of the South American *A. fraterculus* Wied., occurs in Puerto Rico which he has described as *A. fraterculus* Wied., var., *mombinpraeoptans*. It is the one that breeds in some of the mango varieties. The species that breeds in guavas has been described by the writer (2) as *A. unipuncta*. According to Greene it is *A. suspensa* Loew. In this paper the two flies will be referred to as the species breeding in mangoes and the species breeding in guavas. Occasionally, when large numbers are reared, a few adults of the species breeding in mangoes will be found to breed also in guavas. That occurred in some of the experiments, but since it is not significant was not recorded.

The purpose of this paper is to report a series of tests under Puerto Rican conditions of the method of heat sterilization that has been used in Florida against the Mediterranean fruit fly and in Texas against the Mexican orange maggot and other fruit flies. The tests were made during the months of April, May, June and July 1934.

When the Mediterranean fruit fly was present in Florida, sterilized avocados from that State were allowed to be shipped to other parts of the country. The fruit had been grown in a regulated area outside the designated infested areas and was not infested. It was submitted to sterilization as an added precaution.

In the case of the mangoes that have commercial value in Puerto Rico, the conditions are similar in that the varieties to be sterilized have not been found infested and do not appear to be susceptible to infestation.

The sterilization treatment as described by Dr. Lee A. Strong in Administrative Instructions No. 287 (approved July 24, 1930) consists simply of "heating the fruit to a temperature of 110° F or above (not to exceed 112° F) in the approximate center of the fruit and holding the temperature of 110°F or above (not to exceed 112°F) for a period of eight hours".

No specifications as to the exact method or type of equipment to be used in sterilizing the fruit are prescribed. Available information indicates that a high humidity is essential for the best results and that the temperature should be maintained with as little variation as possible above the prescribed temperature of 110° F. For keeping the fruit after the sterilization it should be cooled to a temperature around 45° F as soon as possible.

METHOD OF PROCEDURE

The method of procedure and the equipment described by Mackie (**3**) in California served as a basis for planing the experiments and for constructing the sterilizer.

The sterilization experiments with mangoes and guavas were conducted at the entomological laboratory of the Insular Experiment Station in a sterilizer constructed by Mr. Manuel L. Vicente, Chief of the Division of Agricultural Engineering of the Station. It consists of two sections, a chamber for the fruit provided with a thermostat, thermometer, and racks for wire netting trays, and another section consisting of a water tank, heating unit with three heat switch, fan, motor and switches. The circulation is closed. The air becomes warm and saturated with moisture by passing over the hot water and heats the fruit chamber entering at the upper part, circulating around the fruit and returning to the water tank through an opening at the lower part of the chamber.

To conduct the experiments during office hours, the sterilizer was kept running on "low" during the previous night. The fruit was introduced the next morning at 7:00 A. M. The switch was then turned to "high" and as soon as the temperature reached 43° C (about 110° F) changed to "low". The thermostat maintained it uniformly at 43° C for eight hours.

Mango Varieties

There are two types of mangoes in Puerto Rico, the native seedlings and the more recently introduced selected East Indian varieties. In each type there are some varieties always infested with fruit fly maggots and others which have not been found infested at all and appear to be immune. Of the varieties that have not been found infested, the only native one that has commercial value is the "mango de Mayagüez" or Mayagüez mango. Of the recently imported varieties, the Colombo Kidney has high quality and is prolific. At Ponce there is a large grove of a variety that has been given the owner's name, Mr. Girón. In the island of Vieques there are some varieties that have commercial value. At present the only commercial variety grown on a large scale is the Mayagüez mango.

The Mayagüez mango is medium sized and attractively colored. It ships and keeps well but is very fibrous. There would be a good demand for it however, among West India residents in the United States. If the demand for mangoes higher in quality increased, they would be planted on a large scale.

Only Immune Varieties Have Commercial Value

Even in local markets, mangoes infested with fruit fly maggots have no commercial value. Their exportation to United States markets would be even less practical. Infested fruit can not be rendered marketable by sterilization because, though the maggots are killed, their dead bodies remain inside the fruits where they decompose, together with the pulp tissues previously injured by their tunneling.

The female fruit fly lays her eggs in the mangoes when green and the maggots may become full grown before the fruits are half ripe. For the mangoes to ripen properly they must be picked from the tree when at least half ripe. It would be impossible therefore to pick marketable fruit of the susceptible varieties early enough to prevent infestation.

The admission of sterilized mangoes into the United States is thus rendered doubly safe (1st) by the fact that only varieties that are not infested are marketable, and (2nd) because such sound fruit would nevertheless, and in addition, have been submitted to a treatment that kills the pest if it were present in them.

The Mango Variety Used in the Experiment

The mango variety used in the experiments is the one known as "mango blanco" or white mango. It was not chosen for its commercial possibilities but on the contrary, for its susceptibility to fruit fly infestation. A high percentage of the fruits of this variety is always infested. Since a large number of trees grow on the Station grounds and produce very large crops, procuring the fruit at the right stage of maturity was rendered easy.

The Guava Varieties Used in the Experiments

The guava fruits used in the experiments were of the two common varieties that grow on pastures, waste lands and fence rows on the Island. The two varieties have round-shaped medium sized fruits. The fruits of one variety are sweet, those of the other are sour. High percentages of the fruits of both varieties are ordinarily infested with fruit fly maggots. That does not however, destroy their value, for they are not consumed fresh but used for making preserves and jellies. For cooking purposes, most of the maggots can be made to abandon the fruit by soaking in cold water overnight.

Method of Handling the Fruit

The half ripe mangoes and guavas used in the experiments were picked from the trees the previous day. Some showed the emergence holes of the maggots opening through the cuticle. Emergence holes indicate that some full grown larvae may have left the fruit and also that full grown larvae are present in the fruit. Each lot of fruit to be sterilized or kept as checks consisted partly of fruit with emergence holes. When the fruit had cooled off after sterilization, some having emergence holes were cut open to determine the condition of the larvae. The rest of the sterilized fruits and the checks were kept under observation on moist sand. The appearance of new emergence holes was noted. When the fruits began to rot they were cut open and inspected. The sand on which they stood was then sifted for pupae.

The presence of fruit fly eggs in the half ripe mangoes can be determined by observation of the tips which protude out of the cuticle (2). The species that ordinarily infests guavas lays its eggs entirely underneath the cuticle (2). Their presence in the fruit was inferred by the fact that the infestation of maggots in the checks was about normal.

Preliminary Experiments with Mangoes

Ten preliminary experiments were conducted using the first infested fruits of the 1934 crop which dropped from the trees and were picked from the ground in April. All showed emergence holes when collected.

After the sterilization, some dead maggots were observed on the floor of the chamber underneath the fruit. Some maggots were also found dead with their bodies partially out of the emergence holes. Cutting the fruits open, dead fruit fly maggots of various sizes were found. None was found alive. The cut open fruits were kept under observation on sand until the pulp rotted and inspected daily but no fruit fly maggots developed in them and no pupae were recovered by sifting the sand on which the fruit stood. The number of maggots found per fruit was as follows:

Number of fruits, 5----Number of maggots per fruit: 3, 6, 5, 7, 4
Number of fruits, 7----Number of maggots per fruit: 6, 2, 5, 4, 3, 4, 7
Number of fruits, 6----Number of maggots per fruit: 3, 5, 6, 2, 8, 5
Number of fruits, 8----Number of maggots per fruit: 4, 10, 5, 6, 9, 4, 6, 5
Number of fruits, 12----Number of maggots per fruit: 3, 7, 5, 6, 9, 4, 6, 5, 4, 8, 7, 6
Number of fruits, 15----Number of maggots per fruit: 4, 10, 5, 3, 7, 4, 6, 3, 9, 5, 7, 2, 4, 7, 6
Number of fruits, 8----Number of maggots per fruit: 5, 3, 7, 12, 6, 4, 5, 3
Number of fruits, 7----Number of maggots per fruit: 6, 9, 5, 5, 4, 8, 6
Number of fruits, 10----Number of maggots per fruit: 4, 7, 2, 5, 3, 6, 4, 8, 11, 5
Number of fruits, 7----Number of maggots per fruit: 12, 6, 3, 2, 5, 4, 6.

Final Experiments

When mangoes became abundant in the months of May, June and July 20 lots of 100 apparently infested fruits each were sterilized at different intervals keeping a lot of 100 similar fruits unsterilized as checks. The results were the following:

Experiment No. 1.—Sterilized: percentage of fruits infested----- 0
Check—percentage of fruits infested--------- 73
Experiment No. 2.—Sterilized: percentage of fruits infested----- 0
Check—percentage of fruits infested--------- 67
Experiment No. 3.—Sterilized: percentage of fruits infested----- 0
Check—percentage of fruits infested--------- 87
Experiment No. 4.—Sterilized: percentage of fruits infested----- 0
Check—percentage of fruits infested--------- 70
Experiment No. 5.—Sterilized: percentage of fruits infested----- 0
Check—percentage of fruits infested--------- 84
Experiment No. 6.—Sterilized: percentage of fruits infested----- 0
Check—percentage of fruits infested--------- 74

Experiment No. 7.—Sterilized: percentage of fruits infested 0
Check—percentage of fruits infested 58
Experiment No. 8.—Sterilized: percentage of fruits infested 0
Check—percentage of fruits infested 72
Experiment No. 9.—Sterilized: percentage of fruits infested 0
Check—percentage of fruits infested 57
Experiment No. 10.—Sterilized: percentage of fruits infested 0
Check—percentage of fruits infested 86
Experiment No. 11.—Sterilized: percentage of fruits infested 0
Check—percentage of fruits infested 61
Experiment No. 12.—Sterilized: percentage of fruits infested 0
Check—percentage of fruits infested 45
Experiment No. 13.—Sterilized: percentage of fruits infested 0
Check—percentage of fruits infested 52
Experiment No. 14.—Sterilized: percentage of fruits infested 0
Check—percentage of fruits infested 80
Experiment No. 15.—Sterilized: percentage of fruits infested 0
Check—percentage of fruits infested 71
Experiment No. 16.—Sterilized: percentage of fruits infested 0
Check—percentage of fruits infested 65
Experiment No. 17.—Sterilized: percentage of fruits infested 0
Check—percentage of fruits infested 42
Experiment No. 18.—Sterilized: percentage of fruits infested 0
Check—percentage of fruits infested 78
Experiment No. 19.—Sterilized: percentage of fruits infested 0
Check—percentage of fruits infested 70
Experiment No. 20.—Sterilized: percentage of fruits infested 0
Check—percentage of fruits infested 63

Total sterilized fruits, 2,000, total infested, 0.
Total check fruits, 2,000, total infested, 1,357, percentage infested, 67.8.

No pupae were recovered from the sand on which the sterilized fruits stood. From the sand on which the check fruits stood 4,032 pupae were recovered and 3,200 adults emerged from them. The adults were identified by the writer as the species breeding in mangoes.

The sterilized fruits which were not infested, ripened normally and showed no difference in flavor, texture, or keeping qualities from the non-infested check fruits.

Experiments with Guavas

Ten lots of 50-half ripe apparently infested guava fruits each were sterilized keeping ten lots of 50 similar fruits unsterilized as checks.

Experiment No. 1.—Sterilized: number of fruits infested 0
Check—number of fruits infested 43
Experiment No. 2.—Sterilized: number of fruits infested 0
Check—number of fruits infested 32

Experiment No. 3.—Sterilized: number of fruits infested		0
	Check—number of fruits infested	36
Experiment No. 4.—Sterilized: number of fruits infested		0
	Check—number of fruits infested	41
Experiment No. 5.—Sterilized: number of fruits infested		0
	Check—number of fruits infested	35
Experiment No. 6.—Sterilized: number of fruits infested		0
	Check—number of fruits infested	46
Experiment No. 7.—Sterilized: number of fruits infested		0
	Check—number of fruits infested	30
Experiment No. 8.—Sterilized: number of fruits infested		0
	Check—number of fruits infested	40
Experiment No. 9.—Sterilized: number of fruits infested		0
	Check—number of fruits infested	26
Experiment No. 10.—Sterilized: number of fruits infested		0
	Check—number of fruits infested	32

Total sterilized, 500 fruits, total infested, 0.

Total checks, 500 fruits, total infested, 361, percentage infested, 72.2.

No new emergence holes were observed in the guava fruits that were sterilized, nor were maggots found in them. No pupae were recovered from the sand on which the fruit stood. In the check fruits new emergence holes and living maggots were observed and 983 pupae were recovered from the sand on which the fruit stood. From the pupae, 840 adults emerged which were identified by the writer as the species that breeds in guavas.

Sterilization of Pupae From Mangoes

Although the fruit fly infesting mangoes in Puerto Rico does not pupate inside the fruit, nevertheless, to determine whether the pupae would be affected in the same manner as the eggs and the maggots by the sterilization treatment, 500 pupae were placed among mango fruits and sterilized at 43° C for 8 hours.

The sterilized pupae as well as 500 more similar pupae which served as checks were kept in moist sand. No flies emerged from the sterilized pupae. From the checks, 423 flies emerged. They were identified by the writer as the species that breeds in mangoes.

Sterilization of Pupae From Guavas

The species breeding in guavas, is the one that occasionally infests citrus. In guavas it does not pupate inside the fruit but in citrus it occasionally does. One hundred pupae of this species were sterilized having been placed among guava fruits. No flies emerged from them. From 100 similar pupae kept as check, 76

adults emerged which were identified by the writer as the species that breeds in guavas.

CONCLUSIONS

The tests prove that an exposure of eight hours at 43° C in an appropriate sterilizer is sufficient to kill the eggs, maggots and pupae of the fruit flies that infest mangoes and guavas in Puerto Rico. The treatment does not alter the flavor, texture or keeping qualities of the fruit that is not infested with fruit flies.

SHORTENING THE STERILIZATION PERIOD FOR MANGOES

To determine whether a period shorter than eight hours at 43° C might be sufficient, five experiments were conducted using 50 half-ripe "white mango" fruits in each experiment and keeping an equal number unsterilized as checks. A total of 250 fruits were sterilized for four hours and an equal number kept as checks. None of the sterilized fruits showed new exit holes or was found to contain living fruit fly maggots. No pupae were recovered from the sand on which the sterilized fruit stood. Out of the checks, 112 fruits showed new exit holes and contained living fruit fly maggots. From the sand under the checks 305 pupae were recovered from which 235 adults emerged. They were identified by the writer as the species that breeds in mangoes.

The tests show that four hours at 43° C are sufficient to kill the fruit fly eggs or maggots present in mango fruits. Thus an eight-hour period provides a very large margin of safety.

SHORTENING THE STERILIZATION PERIOD FOR GUAVAS

Five more experiments similar to the previous were conducted using 50 half-ripe guavas in each and keeping 250 similar fruits unsterilized as checks. None of the fruits treated for four hours showed fresh exit holes or was found to contain living fruit fly maggots. No pupae were recovered from the sand underneath them. Out of the 250 fruits kept as checks 186 showed new exit holes and contained living fruit fly larvae. From the sand under the checks 460 pupae were recovered from which 340 adults emerged. The adults were identified as the species breeding in guavas.

The tests show that with the species breeding in guavas, the sterilization period can also be shortened without reducing its effectiveness and that therefore the eight-hour period offers a large margin of safety.

Sterilization of Mangoes Wrapped in Paper

To determine whether eight hours at 43° C would be sufficient to kill the eggs or maggots of the fruit fly in mangoes that have been wrapped in paper similar to that used for packing citrus fruits, 50 fruits were used in each of five experiments, keeping 50 similar fruits as checks. None of 250 sterilized fruits showed new exit holes or was found to contain living fruit fly maggots. No pupae were recovered from the sand under them. Out of 250 check fruits 92 showed new exit holes and were found to contain fruit fly maggots. From the sand under them 340 pupae were recovered and 194 adults emerged. The adults were identified by the writer as the species that breeds in mangoes.

The results of the experiments show that mangoes can be successfully sterilized after having been wrapped in paper.

Sterilization of Mangoes Packed in Crates

To determine whether 8 hours at 43°C would be sufficient to kill the eggs and maggots of the fruit fly in mangoes packed in crates, five experiments were conducted. Thirty half-ripe "white mango" fruits were used in each experiment keeping 30 similar fruits for checks. Three kinds of crates were used: (1) all sides ½ inch white pine wood, (2) bottom and two sides ½ inch white pine wood other two sides and top wire netting and (3) all sides ½ inch white pine wood with an opening 2 inches square covered with wire netting on each side except top and bottom. Ten mangoes were placed in each crate and sterilized. The experiment was repeated five times. The total number of fruits sterilized was 150. No new emergence holes, nor living fruit fly maggots were found in them and no pupae in the sand underneath them. Out of 150 check fruits, 93 showed new emergence holes or were found to contain living fruit fly maggots and 240 pupae were recovered from the sand under the fruits. From the pupae 146 adults emerged which were identified by the writer as the species that breeds in mangoes.

These experiments show that mangoes packed in crates similar to those used commercially for fruits and vegetables can be sterilized to kill eggs or maggots of the fruit fly as readily as if the mangoes were placed on trays.

Sterilization of Mangoes Wrapped and Crated

To determine whether mangoes wrapped in paper, packed in crates and sterilized for 8 hours at 43°C would have the eggs and

maggots of the fruit fly killed, 5 experiments were conducted which were a repetition of the previous one excepting that the fruits before crating were wrapped in tissue paper sheets similar to those used for citrus. No new emergence holes nor fruit fly maggots were found in any of the 150 sterilized fruits and no pupae in the sand underneath them, but of 150 fruits kept as checks, 103 showed new emergence holes or were found to contain living fruit fly maggots and 327 pupae were recovered from the sand underneath them.

These experiments show that mangoes wrapped in paper and packed in crates similar to those used for other fruits and vegetables could be sterilized successfully.

Summary

1. Mango fruits infested with fruit fly maggots have no commercial value and could not profitably be shipped to the United States.

2. Sterilization at a temperature of 43°C for eight hours in a circulating atmosphere saturated with moisture kills the eggs, maggots and pupae of the fruit flies that infest mangoes and guavas in Puerto Rico without unfavorably affecting the flavor, appearance or keeping qualities of the fruit if it is afterwards placed in refrigeration.

3. Sterilization does not render marketable mangoes which have already been injured by fruit fly maggots. Such fruit shows the injury and the dead maggots on being cut open, and decays rapidly.

4. Sterilized mangoes from Puerto Rico could safely be allowed into the United States under permit because (1st) only varieties that are not infested would be shipped and (2nd) the fruits would in addition have been submitted to a treatment which renders them free from the pest if they contained it.

5. The varieties that could be sterilized are the Mayagüez mango, the Girón, the Colombo kidney and some of the better ones from Vieques.

6. Since the period of sterilization of eight hours can be reduced to four hours without rendering the treatment less effective in destroying the insect, the margin of safety is very large.

7. Mangoes can be rendered free from fruit fly infestation by sterilization for 8 hours at 43°C piled on trays, crated or wrapped in paper and crated.

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THE FIRST RECORDS OF THE MOSAIC DISEASE OF SUGAR-CANE IN PUERTO RICO

By George N. Wolcott, *Entomologist.*

The purpose of the present note is to place on record the first observations on the occurrence of mosaic disease of sugar-cane in Puerto Rico, and to supplement the statement of Mr. J. A. Stevenson, Plant Pathologist of the Insular Experiment Station at the time of its discovery here, as to its early distribution. In his final, and presumably definitive, paper on "The Mottling or Yellow Stripe Disease of Sugar-Cane" (Jour. Dept. Agr. P. R., Vol. 3, No. 3, July, 1919), he writes:

> "At the end of the first season's studies as noted in the 1915–16 report, it had attacked the cane in the region bordered by Aguadilla to the west and a line from Utuado to Arecibo along the valley of the Arecibo River on the east. Lack of time did not permit the working out of more exact boundaries, particularly along the south and west."

During the grinding seasons of 1914–15 and 1915–16, the writer was devoting most of his time to making studies on the status of insects of sugar-cane in Puerto Rico, giving special attention to infestations of *Diatraea saccharalis* F., in mature stalks as observed when they were being harvested. Counts of infestations by the moth-borer in units of a hundred stalks were made, either in fields where the cane was being cut or at loading stations near-by, in all sections of the Island. On the status card, not only were spaces available for recording observations on what presumably would be all pertinent factors affecting the abundance or scarcity of the moth-borer, and on the number noted of the other principal insects attacking stalks, but also "Phys. Dead-heart", "Root Disease" and "Other Injury". The only purpose of the entomologist in making observations on diseases was as they might affect the insects, and whenever diseased material was sufficiently abundant or interesting to justify bringing it back to Río Piedras, it was naturally turned over to the Plant Pathologist for determination.

On March 26, 1915, at Añasco, Tablon Pablo, concerning the field southwest of the long railroad bridge, (Status No. 148), containing mixed Rayada cane in first ratoon, the following was written:

"The cane appeared to be dried up: small and shrunken between the joints. The lower part of the field was overflowed by the river and the cane was covered with silt. It appeared to be the worst cane."

On the same day, cane at the loading station at Añasco, coming from Colonia Pacha in the hills, was noted to be "suffering from a stem disease like a leaf spot." Material was brought in to Mr. Stevenson, who examined it carefully at the time and stated that the lesions bore no traces of fungi or bactria, and that he had no idea of what might be the cause of the disease and would not even venture to make a tentative guess, without seeing young material, in an earlier stage of the disease. Travel was not so simple at that time, and as the entomologist had made a sufficient number of insect status examinations at that point for his purposes, the locality was not again revisited for obtaining the required material. Yet the written description of the cane, and his remembrance of the appearance of the lesions indicate that, without a doubt, it was severely cankered with mosaic disease, and definitely establishes a record for Añasco at least a year previous to any given by Stevenson, besides indicating by the condition of the cane that the disease must have been present here for at least two years previously, and possibly several more.

The disease was also present considerably to the south of Añasco, for when accompanied by Mr. R. H. Van Zwalumenburg on April 6, 1915, the status No. 154 at Colonia Carlo Bravo, between hills and the railroad by the road crossing to Mayagüez, bears the notation: "Leaf-spot stem disease."

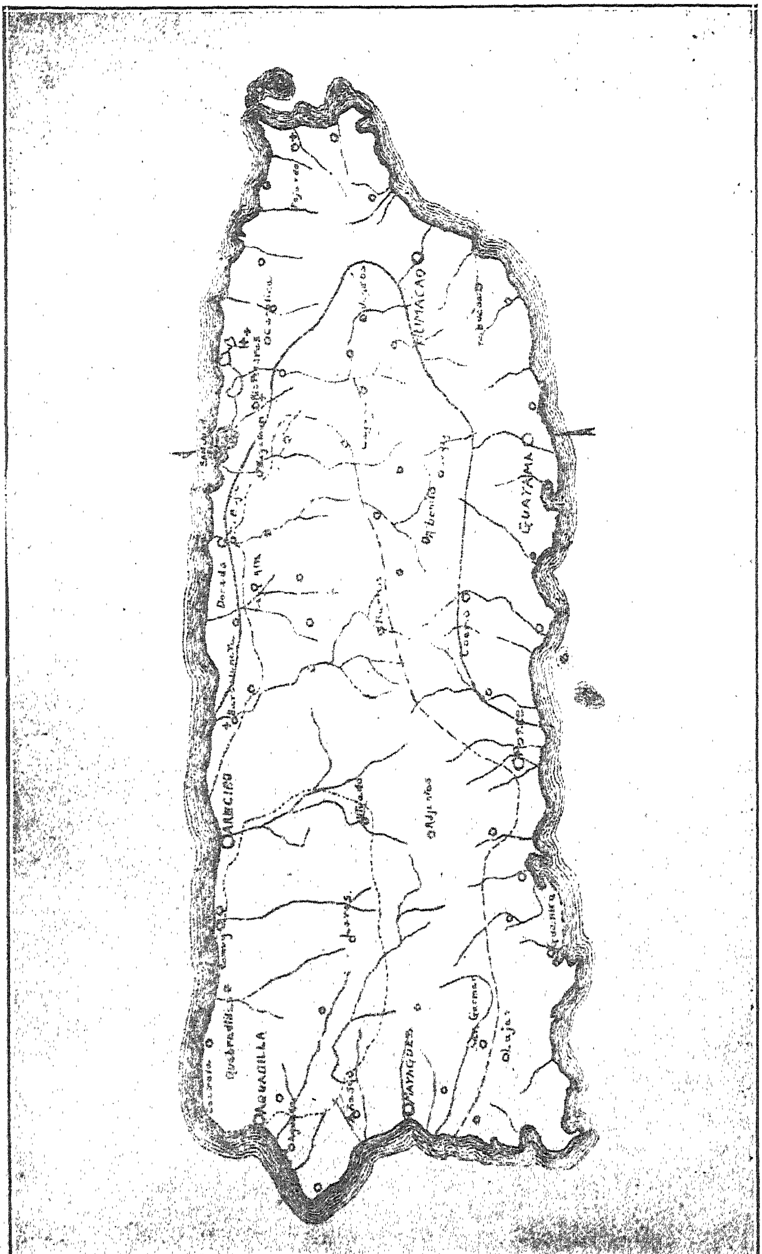
The following year in April, 1916, status observations at Quebradillas, Camuy and Aguadilla record:

"The drying-out disease abundant—elongate lesions between the joints."
"A little of the drying-out disease." (three records)
"Drying-out disease abundant."
"It was cane in a field near to this that suffered so severely from drying-up disease that two Centrals refused it. The buyer said he thought it was due to lack of air drainage. Rainfall had been ample." (Camuy.)

These rceords only confirm Stevenson's statements as to where he first found the disease. Other records made by the entomologist in this year, however, greatly extend the known range of the disease. Status Nos. 166–7–8, all at Filial Amor, record:

"Drying-out disease abundant—bad." (at Colonia Rosario.)
"Drying-out disease abundant." (at Colonia Francisco Román.)
"More of drying-out disease." (at Colonia Emisa.)

Filial Amor is the railroad junction northwest of San Germán, thus these records for 1916 indicate that even this early the disease must have existed far south of the area mapped by Stevenson, and that the original focus of infection may not have been in the hills back of Camuy, but possibly much farther south.



Reproduction of Stevenson's Map, Showing Supposed Early Distribution and Known Later Spread of Mosaic Disease of Sugar-Cane in Puerto Rico. (After Stevenson).

ROOT DISEASES OF SUGAR CANE IN PUERTO RICO

PART I.—NORMAL STRUCTURE OF ROOTS

By MELVILLE T. COOK, *Plant Pathologist*,
Agricultural Experiment Station, Río Piedras, Puerto Rico.

Before starting the studies on the diseases of roots of sugar cane, it appears to be desirable to give a brief review of our knowledge of normal healthy roots. This has been done in other publications and there is nothing new in this brief discussion but it appears desirable in order to make comparisons. When a cutting is planted, it produces two kinds o roots. Very small roots develop just above the node which are known by several names, such as primary, adventitious, etc. Much larger roots are formed at the bases of the buds soon after the shoots start to elongate. They are known as secondary or true roots, etc.

The primary or adventitious roots usually die early but under some conditions presist and form dense mossy like growths. A very large percentage of the large or true roots die early but many of them grow to twelve inchs or more in length. Some few of them attain a much greater length, sometimes as much as six feet. They branch to some extent by the formation of small lateral roots. The number of these small lateral roots is extremely variable. We do not know all the factors that may influence the number of small lateral roots but injuries by insect larvae, fungi and other agencies at or near the apex are important. The writer is inclined to believe that the environmental factors, such as character of the soil, water supply, etc., are extremely important. When a root attains a length of about six or eight inches the cortex usually dies except for three or four inches at the tip. Many people in digging the roots of sugar cane believe these roots are dead, but an examination of the axis cylinder will show that they are alive. The absorption is restricted entirely to the small amount of living cortex near the tip. The dead cortex usually contains many fungi and bacteria, usually saprophytic forms.

The structure of the large roots is practically the same as for the roots of most plants. An axis cylinder, a cortex, an epidermis and a root cap. All of which are shown in longitudinal section (figure 1). The tracheary tubes begin to form early and just back of the root tip (figure 1). They originate from several single rows of

cells in the axis cylinder and are arranged so that they form a circle in cross section (figures 1, 2 and 12). They are small at first (figure 7) but increase in size (figures 8 and 9). This relationship to the surrounding cells is shown in figures 5 and 10. They are cells of the axis cylinder which differentiate, enlarge and exert a pressure on the surrounding cells (figures 5 and 10). The density of the protoplasm in these cells is variable (figures 5, 10 and 11). The general appearance of these cells is that of great activity until they have reached their full growth when the contents undergoes degeneration (figure 6). Eventually the cell walls between the cells of a row disappear and the tracheary tube is complete.

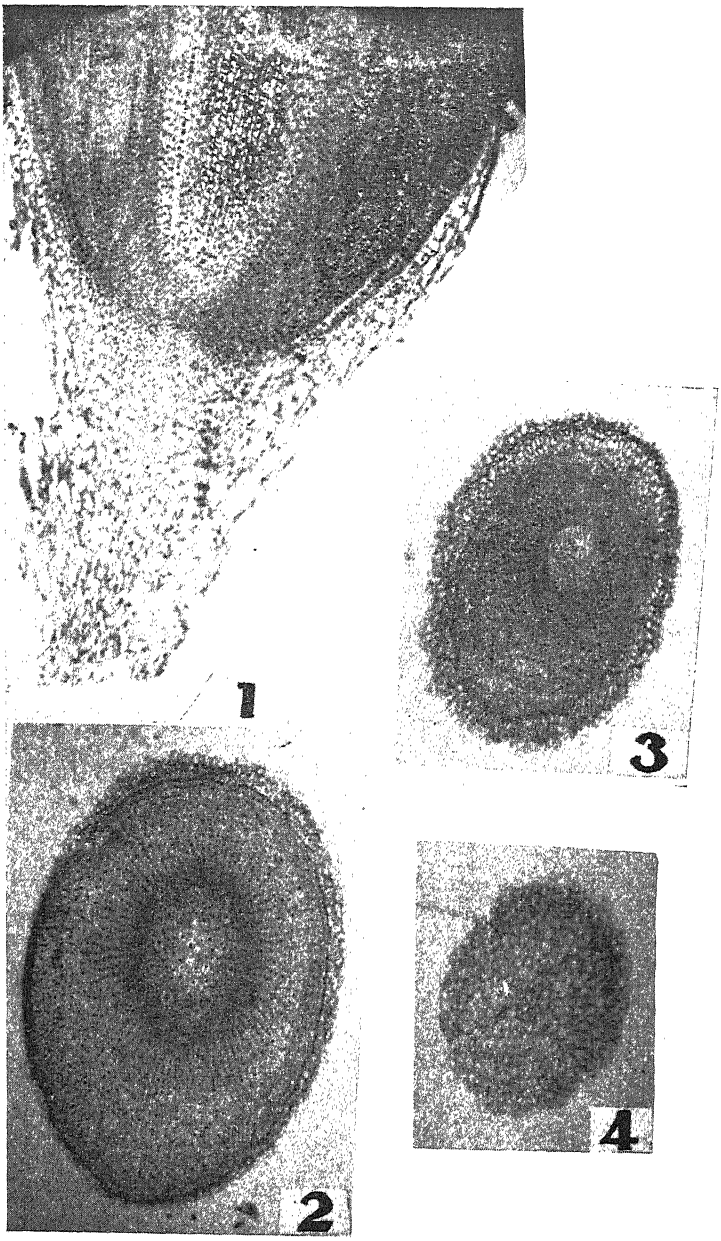
The demarkation between the axis cylinder and the cortex and between the cortex and epidermis appear early and are well defined (figures 12, 13 and 14). The axis cylinder may presist for a long period, as previously stated in this paper, but in other cases the entire root dies very early.

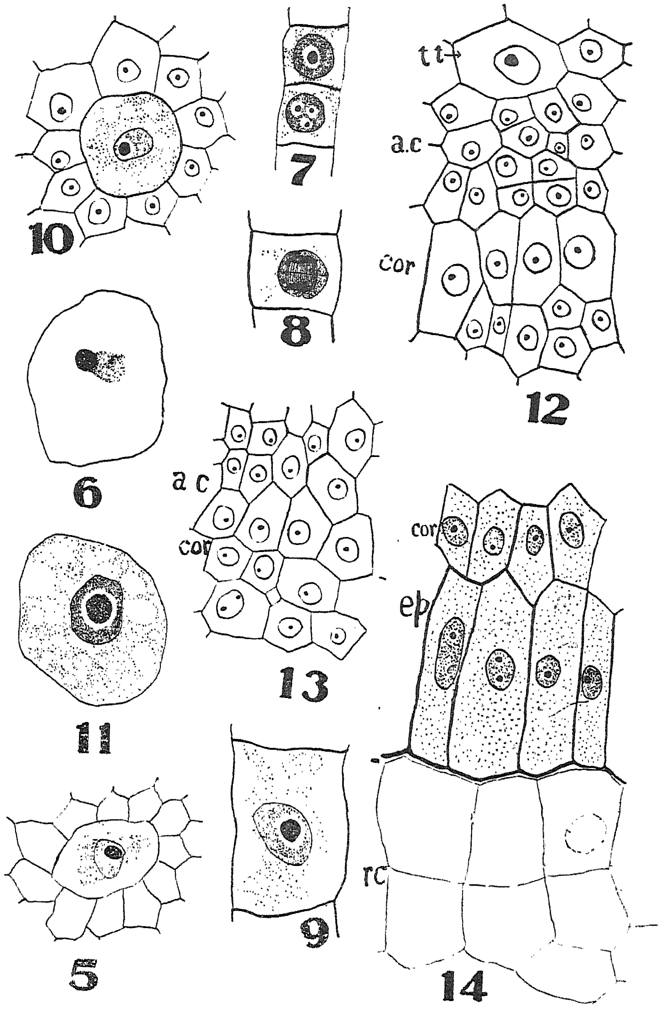
The root cap is the same as in the roots of most plants. It projects beyond the apex of the root. The cells at point of origin are well supplied with protoplasm (figure 4) while those most remote contain little or no protoplasm (figure 1). The root cap extends up the sides of the root tip for a short distance and the demarkation between epidermis and cap is very distinct (figures 1, 2, 3 and 14).

The injuries to the root originate in the active, healthy cortex. Fungi and bacteria may be found in the dead cortex of the old roots but their presence does not indicate that they are injurious. Most of them appear to be saprophytic. Of course some of the organisms found in the dead cortex may cause some injury. The healthy cortex is attacked by fungi, bacteria, nematodes, the larva of insects and possibly other forms of life. The results of the writers studies on these forms of life will be published from time to time.

Studies on *Marasmius sacchari*, which has been referred to so often and from so many different countries as a cause of root diseases, have been made by the writer and the results published in the proceedings of the Fourth Congress of the International Society of Sugar-Cane Technologists held in San Juan, Puerto Rico, March 1932, under the title of "The Parasitism of Marasmius sacchari Wakker" and in The Journal of the Departament of Agriculture of Puerto Rico, Volume XVI, No. 2, pages 213–226, 1932, under the title of "*Marasmius sacchari;* a Parasite of Sugar Cane". The latter is the more complete. It should have been included in this series on Diseases of Roots of Sugar Cane.

PLATE IX.

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Explanation of Plates

Figure 1.—Longitudinal section of tip of root showing axis cylinder with one row of cells that are to form a tracheary tube; cortex, epidermis and root cap.

Figure 2.—Cross section of tip of root showing axis cylinder and a circle of large cells that are to for tracheary tubes; cortex, epidermis and a small amount of the root cap around the margin.

Figure 3.—Cross section of root tip lower down and a little above apex showing axis cylinder, cortex, epidermis and root cap around the margin.

Figure 4.—Cross section through the root cap.

Figures 5, 10 and 11.—Cross sections of cells that are to form tracheary tubes. Note difference in protoplasmic contents.

Figure 6.—Same in state of disintegration.

Figures 7, 8 and 9.—Longitudinal sections of cells that are to form tracheary tubes.

Figure 12.—Cross section of root tip showing cortex, axis cylinder and one cell of a future tracheary tube.

Figure 13.—Cross section of a root tip showing primitive axis cylinder and cortex.

Figure 14.—Cross section of root tip showing parts of cortex, epidermis and root cap.

a.c.—axis cylinder. Cor-cortex. ep = epidermis. r.c. = root cap. tt = tracheary tube.

The photographs for figures 1 to 4 were made by Dr. Harold T. Cook.

PART II.—A NEW PARASITIC FUNGUS IN THE ROOTS OF SUGAR CANE

This fungus was found on the roots of sugar cane growing in pots, while the writer was studying another disease. The writer did not make a microscopic examination of the roots at the time but put a large number in a killing fluid for later study. Therefore, the disease was not recognized as new until after the roots had been sectioned and stained. Upon the discovery that the fungus was new to science, the writer made a search for additional material in order to study living material but without success. Therefore, these studies are based entirely on material that had been sectioned and stained. However, there was a sufficient amount of material for study.

The material was killed in weak Flemming and most of it was stained with Haematoxylon and iron-alum.

The *symptoms* of the disease visible to the unaided eye are of little or no importance for diagnostic work. They appear as small reddish spots which cannot be distinguished from spots due to other causes. The fungus is restricted to the younger parts of the roots. It is doubtful if it ever attacks a root more than 1½ inch back of the tip.

The *importance* of the disease cannot be determined until a more thorough study can be made. The fungus was found in great abundance in some roots and had completely destroyed the contents of many cells. It was found on four varieties, growing in pots and well supplied with water. They are Uba, M 28, PR–801, POJ–2878, SC–12(4) and BH–10(12). It was most severe on PR–801. It has not been found in the field. The nature of the disease is such that a severe outbreak might prove very destructive, The taxanomic relations of the organism are such as to indicate that it will thrive best in soil well supplied with water.

The *fungus* is found in the epidermal cells and cortex but has not been found in the axis-cylinder. It sometimes occurs in masses which have been estimated to contain between 150 and 200 cells, but it also occurs in single cells throughout the cortex. There is no enlargement of the host cells. The fungus appears as a plasmodial mass which almost completely occupies the cell (Figs. 1–3). In most cases there is a single mass, while in a few others there may be several of these masses. (Figs. 4–6) This mass may be vacuolar or densely granular. (Figs. 1–2). In the young stages the nuclei are

not visible, (Figs. 1–2) but they develop in great numbers with age (Figs. 3–4). In the great majority of cases the cell wall is thin but always distinct (Figs. 1–2) but in some cases it is very thick (Fig. 3). These thick walled cells appear to be resting spores.

The plasmodium produces a germ tube which punctures the cell walls and penetrates one to four cells, possibly more, although four was the largest number observed. (Figs. 5–23). The writer never observed the germination of more than one plasmodium in a cell. There was never more than one tube to a plasmodium and branching was observed in one case only (Fig. 13). Most of the germinating plasmodia were large but two small ones were also observed (Figs. 12 and 14 ×). Bensaude (2) reported a plug of dense protoplasm at the tip of the tube. No such plug was observed in any of the writer's preparations. The formation of the tubes and zoospores have a superficial resemblance to those of *Diplophlyctis intestina* as described by Karling (4).

The tubes usually grew more or less in a direct line, but there were some exception. In one case the tube grew into the form of a letter U (Fig. 15). In the great mayority of cases the tube grew in the direction of the epidermis. All the exceptions were a considerable distance from the surface. The writer is unable to say whether this indicates some type of tropism or not.

The formation of nuclei and spores was not correlated with the formation of the germ tube. Sometimes the germ tube is without any evidence of nuclei (Figs. 9, 10, 11, 12, 14 and 16) while in others the nuclei are very distinct and numerous (Figs. 7, 8, 13, 15, 17 and 20) and in still others the spores are formed before the tubes have made much progress (Figs. 18 and 19). The tubes penetrated the cell walls in all cases observed except one in which it went through the wall of its own cell and then between the walls of other cells (Fig. 16). A few cases were observed in which the germ tube was unable to penetrate the cell wall but pushed it forward (Fig. 20).

The spores are numerous, more or less spherical and uninuclear with very thin but distinct walls. In some cases the germ tube passes through the epidermis and the spores are emptied into the soil (Figs. 14 and 23) while in other cases they are emptied into another host cell.

The spores that empty into the soil, presumably penetrate the epidermal cells of the same or other roots. Bensaude (2) reports a discharge of spores directly into the soil. Actual penetration was not observed but many cases were observed in which the epidermal cells were infected (Figs. 41 to 42). Ciliated stages of the spores

were not observed but many preparations showed amoeboid characters. It is possible that a study of fresh material would have shown ciliated spores.

The behavior of the organism in the host was observed in many preparations. They were amoeboid and frequently united as shown by the number of nuclei (Figs. 30–34 and 41). In some cases they tended to become filamentous (figs. 35 and 37) and many of them penetrated cell walls (Figs. 38 and 39). They did not grow and unite with equal rapidity (Figs. 29–39). Sometimes large plasmodial bodies were found in the same cell with spores (Figs. 29–30).

A careful study of the available material leads the writer to believe that many of the sporangial bodies mature their spores without the formation of a germ tube. The formation of tubes was not observed in any of the thick walled sporangia (Fig. 3) although a careful search was made of the adjoining sections of many of them. Yet these thick-walled sporangial bodies produced an abundance of spores.

The thick-walled spores (or sporangia) were apparently resting. Roughened, thick-walled spores (or sporangia), such as are described and figured by Woronin (**6**) and Bensaude (**2**) were observed (Fig. **48**) but the writer is inclined to believe that this roughness is due to plasmolosis and shrinkage.

The possibility of a second species attracted the attention of the writer. A few sporangia were observed in which the spores were much smaller than the others (Fig. 21, 22) and many cases were observed in which small spores were germinating in the host cells (Fig. 36). These small spored sporangia were very few, but the germination and behavior of the spores appeared to be the same as in the large spored forms. The large and small spored forms were not observed to unite or have any relationship whatever.

Double infection of the large host cells by the large-spored forms was observed in many cases (Figs. 43–46. The writer's opinion is based on the fact that young sporangia and spores in various stages of development were observed in many host cells.

Abnormal sporangia were of frequence occurrence. In these cases the sporangia did not develop the spherical body but developed a worm-like structure which penetrated the walls of the host cells and produced spores in the same manner as the normal, spherical sporangia (Fig. 24–28).

Discussion

The life history of this organism is practically the same as Olpidium, with slight variations, except that the writer has not seen flagella on the spores. It is possible that flagella are present and that they can be seen in living material. Therefore, the writer will place this species tentatively in the genus Olpidium. However, it is very evident that the species is new.

Olpidium sacchari n. sp. Sporangia usually solitary in cells of the host, spherical, multinucleate, germinating by a single tube. Zoospores numerous, uninucleate, amoeboid, uniting to form plasmodia; sporangia 2.66—3.5μμ resting spores spherical and thick walled. Resting spores spherical with thick, smooth walls.

Sporangium saepius in cellulis hospitis solitarium sphericum multinucleatum unico tubo germinante; zoosporae numerosae uninucleatas amoeboideae in plasmodia conjugantes; sparangia 2.66—3.5uu sporae immobiliae sphericae parietibus crassis.

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2. **Bensaude, Matilde,** A species of Olpidium parasitic in the roots of tomato tobacco and cabbage. Phytopathology **13**(10): 451–454. 1923.

3. **Griggs, R. F.** Monochytrichum, a new genus of the Chytridiales, its life-history and cytology. Ohio Naturalist **10**(3): 44–54. 1910.

4. **Karling, J. S.** Studies in Chydriales–II. Contribution to the life history and occurrence of Diplophlyctis intestina (Schenk) Schreeter in cells of American Characeae. Amer. Journ. Bot. **15** (3): 204–214. 1928.

5. **Kusano, S.** On the life history and cytology of a new Olpidium with special reference to the copulation of motile isogametes. Journ. Coll. Agri. Tokyo. **4**: 141–199. 1912. (Rev. in Trans. Brit. Myc. Soc. **4**: 291–1913.

6. **Woronin, M.** Plasmodiophora Brassicae, Urheber der Kohlpflanhernie. Jahrb. Wiss. Botanik. **11**: 548–574. 1878.

Explanation of Plates

Figures 1 to 6.—Plasmodia in host cells. In figure 1 the protoplasm is vaculolate; in 2 it is dense and shows first evidence of formation of nuclei; in 3 the nuclei are prominent and the wall thick. Figures 1 and 2 will produce germ tubes but figure 3 will

not. Figures 4, 5 and 6 show two or more sporangia in single host cells. In figure 6 one sporangium is forming a germ tube.

Figures 7, 8 and 9 show germ tubes and nuclei in various stages of formation.

Figures 10 to 14 show sporangia of different sizes and germ tubes. Figures 10 and 13 show two undeveloped sporangia; 11 and 14 show tips of tubes of sporangia not shown in the sections; the sporangia in figures 12 and 14 are very small; the tube in figure 13 is branched. This is unusual. e = epidermal cells.

Figure 15.—The germ tube is curved. This is unusual.

Figure 16.—A germ tube passing between the cells instead of through them. This is unusual.

Figures 17, 18 and 19.—Zoospores in various stages of formation.

Figure 20.—A germ tube has pushed the wall of the host cell forward instead of penetrating it. This is unusual.

Figures 21 and 22.—The zoospores are very small. Note the size as compared with 19.—e = epidermal cells.

Figure 23.—An unusually long tube. e = equals epidermal cells.

Figures 24 to 28.—Abnormal sporangia.

Figure 29.—A host cell containing a large number of zoospores that have not been injected into the soil. Also one large sporangium.

Figures 30 to 34.—Host cells in which the zoospores are uniting to form sporangia.

Figures 35 to 39.—Host cells in which the sporangia are amoeboid. In figures 38 and 39 the sporangia have penetrated the walls of the host cells.

Figure 40.—Two large sporangia in adjacent cells have united and are forming a germ tube.

Figures 41, 42 and 47.—Plasmodia in epidermal cells of the host. e = equals epidermal cells. Apparently the zoospores penetrated from the soil.

Figures 43 to 46.—Cells of the host in which there are sporangia of different ages, probably due to infections at different times.

Figure 48.—An irregular shapped sporangium probably due to plasmolysis.

PLATE XI.

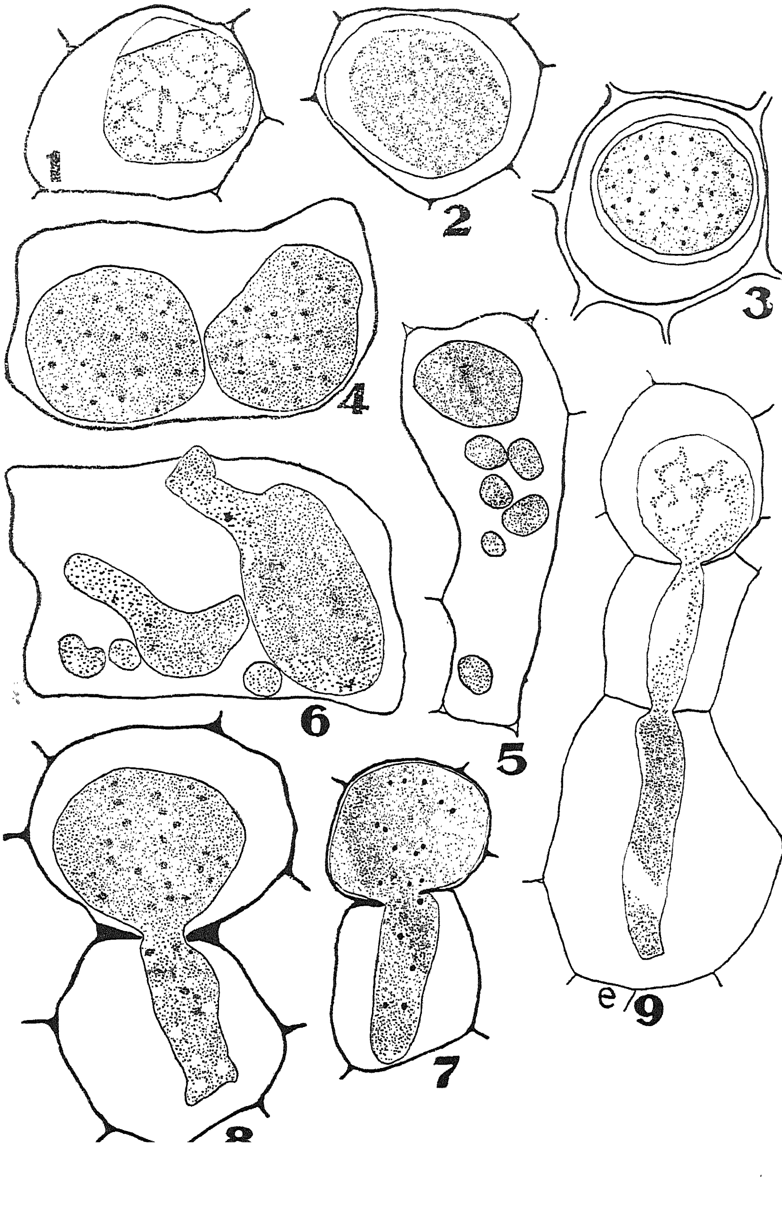


PLATE XII.

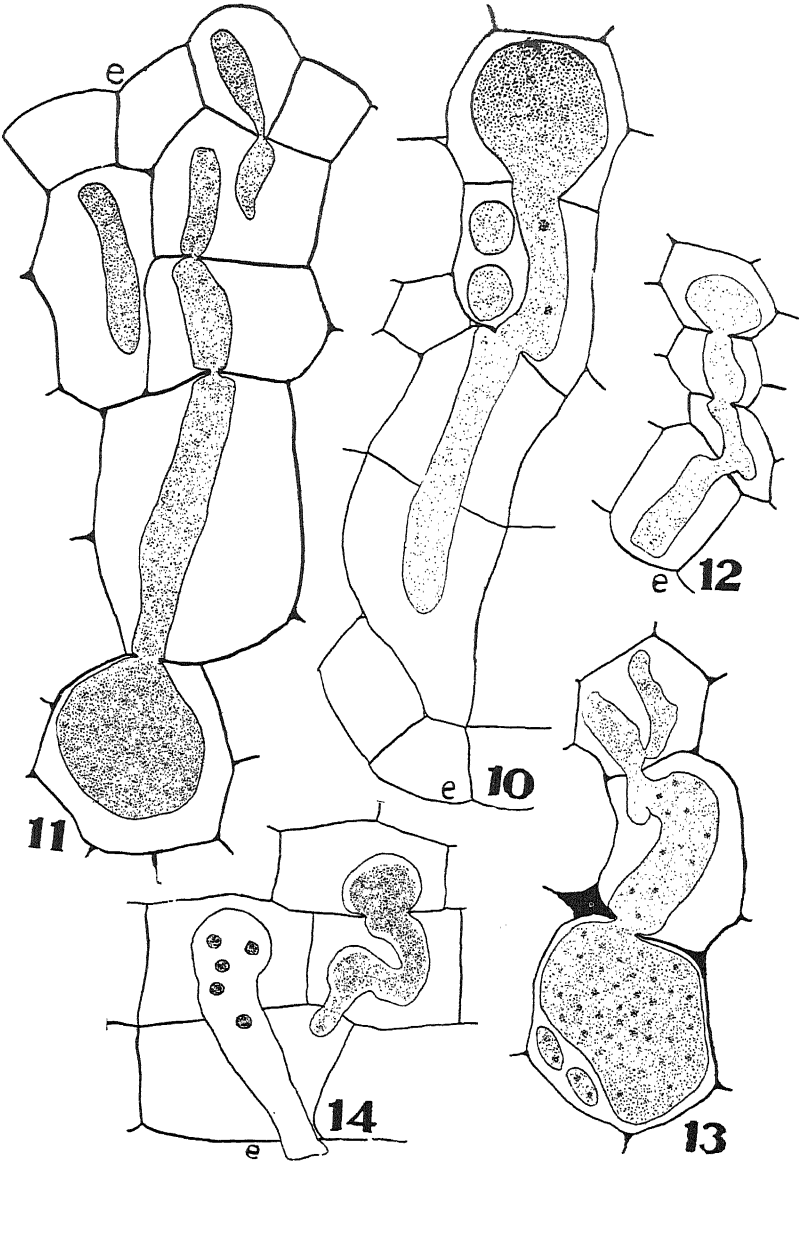


PLATE XIII.

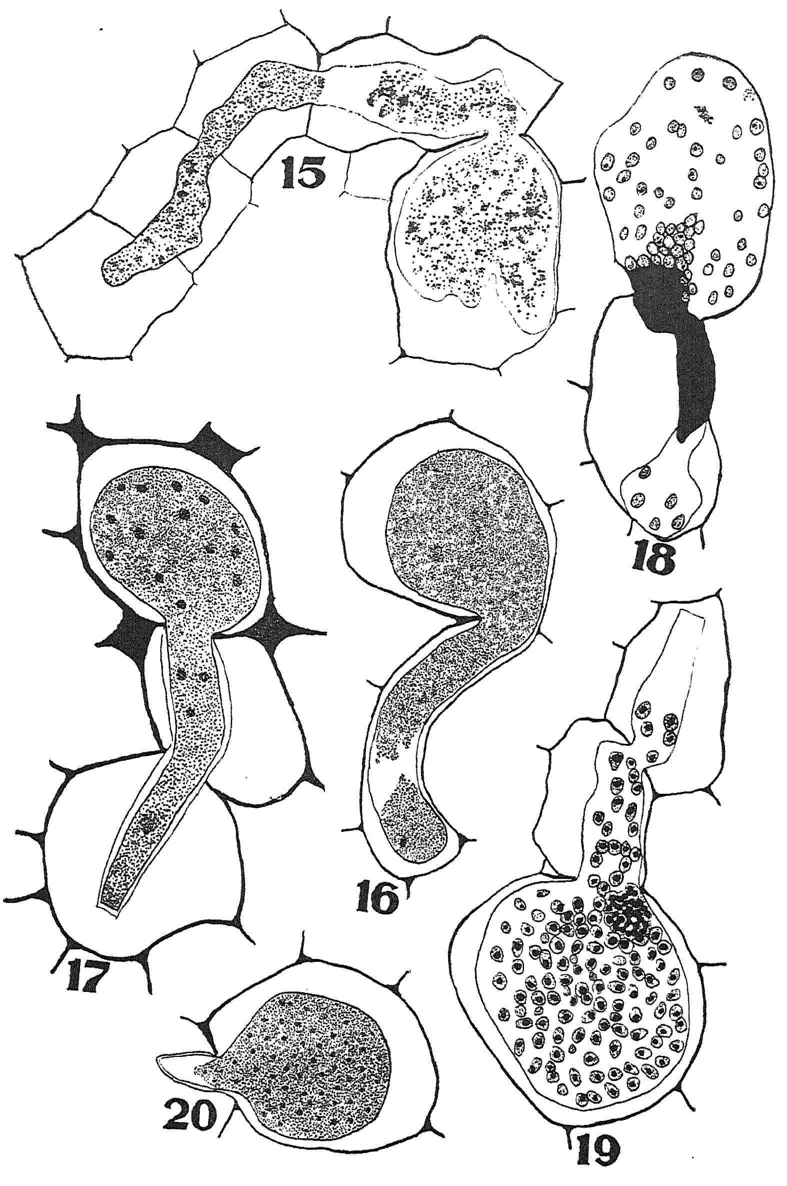
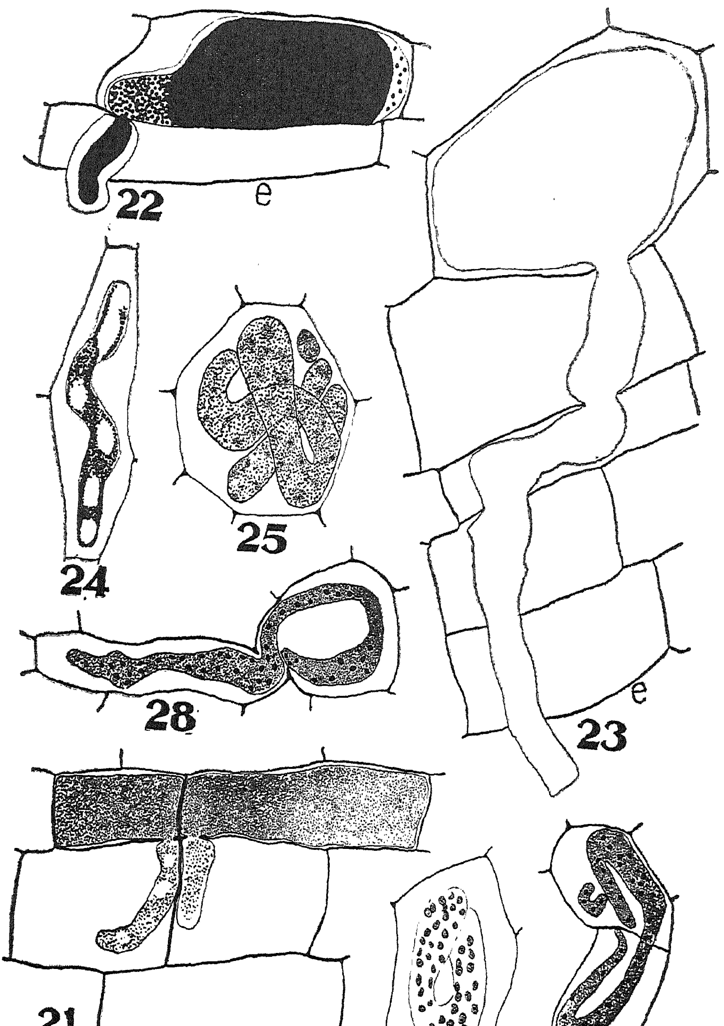
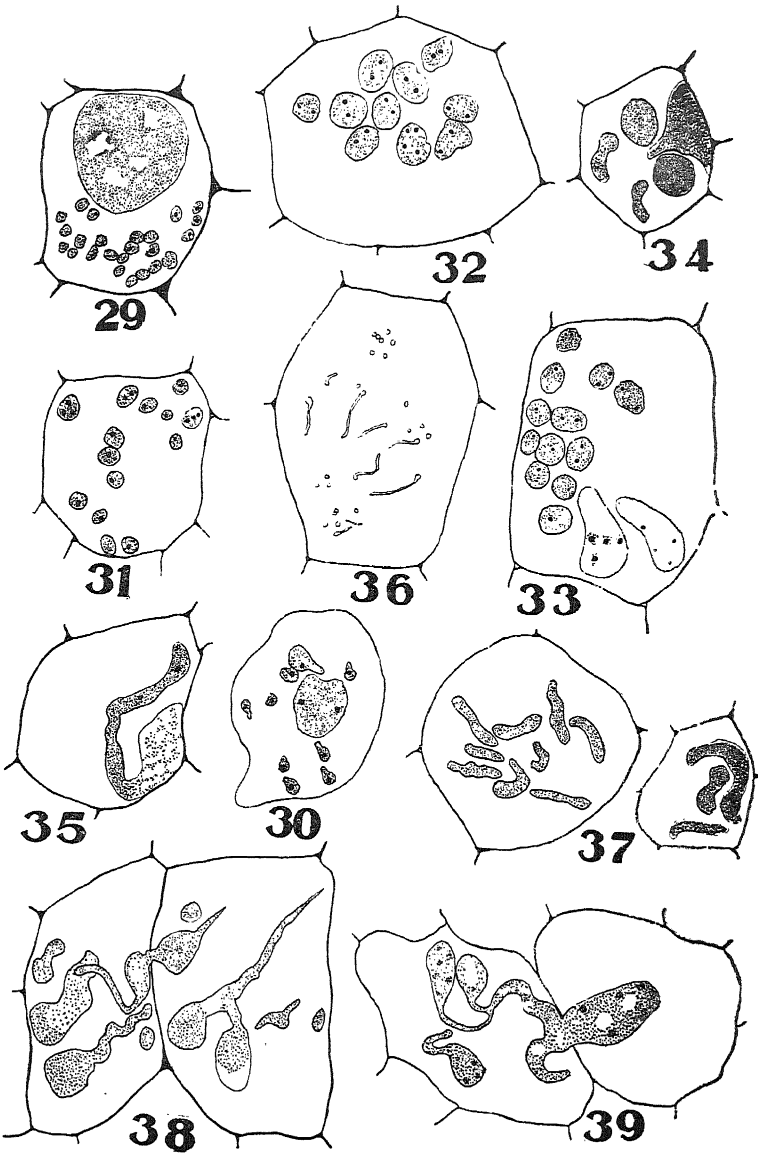


PLATE XIV.

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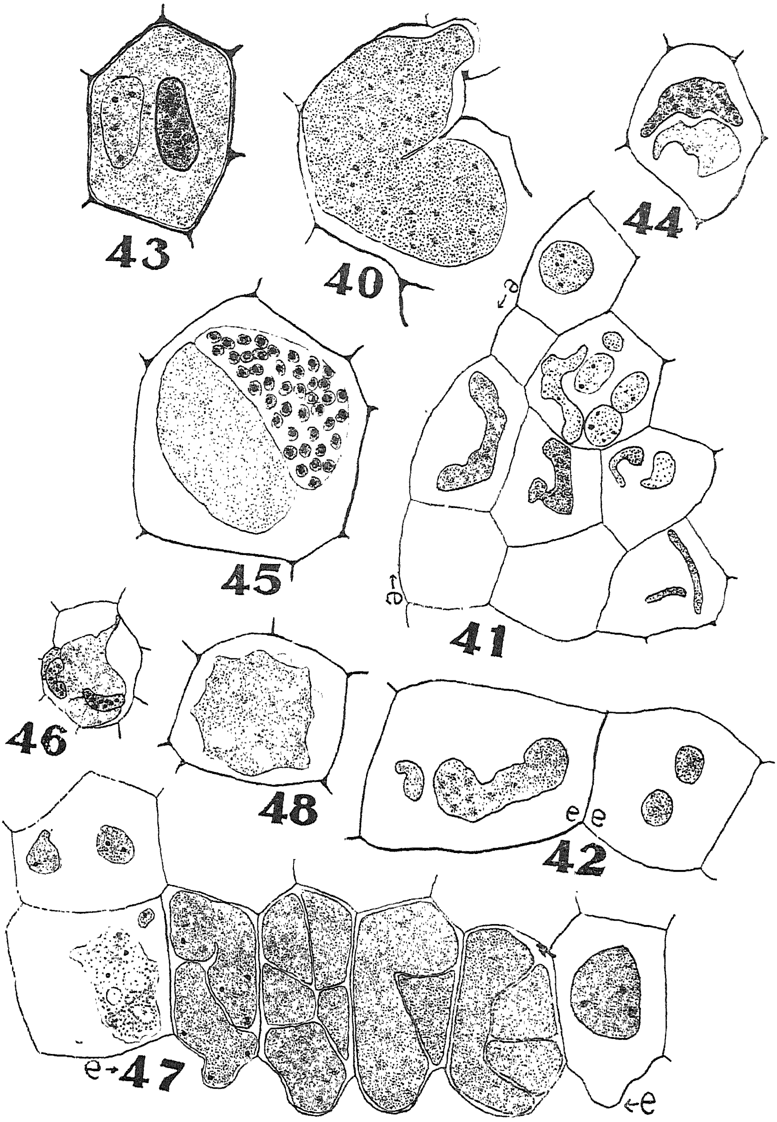
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FIRST SUPPLEMENT

TO

PARTIAL BIBLIOGRAPHY OF VIRUS DISEASES OF PLANTS *

By JOSÉ I. OTERO, *Librarian*, and MELVILLE T. COOK, *Plant Pathologist*, Agricultural Experiment Station, Río Piedras, Puerto Rico.

INTRODUCTION

This first supplement of "Partial Bibliography of Virus Diseases of Plants" is presented to the students of virus diseases of plants, hoping that it will make the original more useful.

After the publication of the above-mentioned work, we have been favored by a great number of investigators on virus with advices, corrections and contribution of papers for which we very sincerely thank all of them. We appreciate the many encouraging letters that we have received from many students interested in virus disease investigations.

It is materially impossible to locate and collect all the literature with our limited library facilities. There may be errors in this supplement as well as in the original; therefore, we will appreciate the cooperation of workers who may be interested in succeeding supplements. Please call our attention to errors, omissions, etc., and send us new papers for citation.

Address correspondence to the Junior author.

This supplement contains:

1. First Supplement to Partial bibliography of virus diseases of plants.
2. Index to this Supplement.
3. 1st Appendix.—Index to Partial bibliography of virus diseases of plants.
4. 2nd Appendix.—Authors' Index of Partial bibliography of virus diseases of plants.
5. 3rd Appendix.—Errata to Partial bibliography of virus diseases of plants.

* Journ. Agric. Univ. Puerto Rico 18(1–2): 1–410, 1934.

Afzal, Husain M.

A note on a growth abnormality of Punjab—American cottons. Indian Journ. Agric. Sci. **3**(5) : 933, 1933.

Report on a disorder of cotton which was first noticed in 1930 in the Canal Colonies of the Punjab and which reappeared with great severity in 1932. The varieties affected are American. The author states that the disease has great similarity to ''stenosis'' reported by O. F. Cook from Haitian cotton. He attributes the disease to a virus and gives description.

Ainsworth, G. C.

Virus disease investigations. Expt. & Res. Stat. Nursery & Mark. Gard. Indus. Devel. Soc. Cheshunt. Ann. Rpt. **18**: 39-45, 1933.

-------------, **Berkeley, G[raven] H[ugh] & Caldwell, John**

A comparison of English and Canadian tomato virus diseases. Ann. Appl. Biol. **21**(4) : 566-580. 1934.

After a comparative study of Canadian and English tomato diseases it was found that the commoner tomato virus diseases occur in both countries. Tomato streak caused by the same single virus occurs in both countries, but streak due to a mixed virus infection appears to be more common in Canada. Several virus diseases with their causal viruses are described.

A comparison of certain English and Canadian potato viruses found infecting tomatoes. Ann. Appl. Biol. **21**(4) : 581-587, 1934.

The author compared potato viruses isolated from Canadian tomato material. The different viruses which corresponded to the mild and virulent forms of the latent or ''healthy potato'' virus were all considered to be strains of potato virus which differed primarily in virulence. It was found that immunity against a virulent strain of the virus was conferred on tomato plants by inoculation with a mild strain.

Virus disease investigations. Cheshunt Exper. & Ros. Stat. Herf. 19 Ann. Rpt. **1933**: 54-64, 1934.

This rather extensive report includes interesting data on several virus diseases of economic importance as well as on uncultivated host plants.

Mosaic disease of the cucumber. Ann. Appl. Biol. **22**(1) : 55-67. 1935.

Cucumber virus No. 1 is closely allied with Johnson's cucumber virus No. 1. It is mottle yellow. No. 3 is a green mottle mosaic. No. 4 is associated with No. 3. The author describes these viruses and the symptoms produced by them.

Allen, H. F.

Causes and effect of dahlia mosaic. Midwest Dahlia News **2**(3): 6–8, 1934.

Altson, R[alph] A[bbey]

Report on a suspected outbreak of infectious mosaic disease among certain canes in the Colony. I & II. Journ. Bd. Agric. British Guiana. **18**(3): 216–225, 1925.

The author reports in Part I an infection of mosaic (infectious chlorosis) in a plantation of sugar cane of the variety BH-10(12) brought from Barbados 1920 which, as preventing measure, he recommended to be eradicated. The infection was as high as 80 per cent prior to its eradication. In one instance the infection was observed on Ba. 6032. The author states that in no instance has there been any indication of spread to neighboring varieties of canes or to weed grasses. He gives a brief general account as to the nature of the disease and recommendations to prevent its spread. In Part II he reports that the above disease is not infectious and that it is not mosaic, giving his evidence and conclusions.

The spread of cane mosaic in the West Indies. Int. Sugar Journ. **27**(318): 293, 1925.

Review of a visit by the author to Jamaica, Costa Rica and Trinidad. Mosaic of sugar cane is the most serious problem. In some cases 100 per cent of the canes are infected. He gives yield and cost data. He reports also that up to this date sugar-cane mosaic disease has not appeared in British Guiana.

Ando, H.

(On dwarf disease of rice plant.) Journ. Jap. Agr. Soc. No. **347**: 1–3, 1910.

Anonymous.

(Dwarfed rice plant, its causes and control measures). Japanese Dept. Education. Official Gazette No. **2192**: 231. 1890.

(Results of Agricultural Experiments). Nara Agric. Expt. Sta. Ann. Rpt. **3**: 51–61, 1897.

Experiments with dwarf disease of rice plant.

(Experiments with dwarf disease of rice plant. Results of Agricultural Expriments). Hyogo Agric. Expt. Sta. Rpt. **1**: 68–82, 1895; Rpt. **3**: 16–18, 1896; Rpt. **5**: 21–22, 1897; Rpt. **7**: 139–141, 1898; Rpt. **9**: 121–123, 1899.

(Experiments with dwarf disease of rice plant). Hiroshima Agric. Expt. Sta. Bull. **7**: 21–39, 1903.

(Experiments with the leafhopper in Results of Experiments with insect pests.) Shiga Agri. Expt. Sta. Reports **1**: 111-169, 1899; **2**: 1–26, 1900; **3**: 25–55, 1901; **4**: 19–65, 1902; **5**: 1–37, & (1)—(36), 1904; **6**: 1–43, 1906; **7** & **8**: 1–43 & (1)—(50), 1908.

(Experiments with dwarf disease. Results of Agricultural Experiments). Okayama Agric. Expt. Sta. Rpt. **3**: 62–70, 1902; **5**: 57–64, 1903; **7**: 51–53, 1904; **11**: 131–138, 1906; **13**: 169–171, 1907; **15**: 109–111, 1908; **19**: 69, 1909.

(On dwarf disease of rice plant). Kyoto Agric. Expt. Sta. Sp. Bull. **11**, 12 p., 1910. (Rice of the Prefecture of Okayama Prefecture. 300 p., 1910.

Rice disease on p. 189–193.

(Experiments with dwarf disease of rice plant.) Shiga Agric. Expt. Sta. Spec. Bull. p. 56–65, 1906. No. **2**: 35–51, 1910.

(Dwarf disease of rice plant). Miyazaki Agric. Expt. Sta. Sp. Bull. **5**, 26 p., 1915.

Miyazaki Agric. Expt. Sta. Ann. Rpts. **1913**: 32, 1914; **1914**: 29–30, 1915.

Shiga Agricultural Experiment Station. Ann. Rpts. **1907**: 55–59; 1908; **1908**: 52–56, 1909; **1909**: 52–54, 1910; **1910**: 54–56, 1911; **1911**: 58–60, 1912; **1912**: 75–78, 1913; **1913**: 128–130, 1914; **1914**: 29–30, 1915; **1915**: 167–168, 1916.

Notes on dwarf disease of rice plant.

Kagoshima Agric. Expt. Sta. Ann. Rpts. **1912**: 46, 1913; **1913**: 48, 1914; **1914**: 39–43, 1915; **1915**: 94, 1916.

Nagano Agric. Expt. Sta. Ann. Rpt. **1915**: 130–134, 1916.

"Matizado" da canna en Porto Rico (Sugar-cane mosaic in Porto Rico). Biol. Min. Agric. Ind. Com. Brasil **8**(11): **91**, 1919.

Yamanashi Agric. Expt. Sta. Ann. Rpts. **1916**: 88–91, 1917; **1917**: 87–89, 146–147, 1918; **1918**: 48, 69, 1919; **1919**: 39, 1920.

The degeneration of the potato. Gard. Chron. **76**: 1978, 1924.

Popular.

(Imperial Agric. Expt. Sta. Ann. Rpts. **1906**: 53–54; **1909**: 59; **1912**: 29, 1914; **1913–1915**: 40–41, 1917; **1916**: 28; 1918; **1922**: 68–70, 1924; **1923**: 33, 1925).

Historico do mosaico da canna. (History of cane mosaic). Bol. Agric. Bahia, Brasil **1926**(4–9): 25, 1926.

O mosaico da canna de assucar (Sugar-cane mosaic). Circ. Inst. Biol. Def. Brasil, 1926.

Bureau of Sugar Experiment Station. Fiji Disease. Queensland Agric. Journ. **26**(4): 280–281, 1926.

O mosaico da canna (Cane mosaic). Bol. Agric. Zoot. Vet., Minas Geraes, Brasil, **1**(6): 121, 1928.

(A survey on the distribution of plant diseases and insect pests.) Japanese Dept. Agric. & For. Bur. Agric. **2**, 341 p., 1929.

Notes on dwarf disease of rice on page 16–19.

Department of Botany and Plant Pathology. Oregon Agric. Expt. Sta. Director's Bienn. Rpt. **1926–28**: 97–101, 1930.

This report includes notes on several virus diseases.

O mosaico da canna (Sugar-cane mosaic). O Campo, Brasil **1**(1): 135, 1930.

O mosaico da canna (Sugar-cane mosaic). Mem. Inst. Oswaldo Cruz, Brasil, 1930.

O mosaico nos cannavieaes de Pernambuco (Mosaic in the fields of Pernambuco). Rural Brasil **3**(12): 417, 1930.

O mosaico da canna de assucar (Sugar-cane mosaic). Fazenda Fluminense, Brasil **1**(6): 18, 1930.

Mosaic and allied diseases of the potato. Ministr. Agric. & Fish. London Adv. Leaflet. **139**, 4 p., 1932.

Insect transmission of spike-disease. Nature **132**: 592–593, 1933.

Contribution á la connaissance de la maladie de l'enroulement des feuilles de la pomme de terre. (Contribution to the knowldge of the leaf roll disease of potato). Progr. Agric. & Vitic. (Montpellier) **100**: 507–509, 1933.

Results from imported canes. South African Sugar Journ. **17**(11): 573–575, 577, 1933

A practice against recognized scientific procedure has been introduced on a private farm in South Africa. Corn was planted between sugar-cane rows, and it was found that streak infection was reduced. It is claimed that the vector of streak *Cicadulina mbila* prefers to feed on corn rather than on sugar cane.

Spotted wilt of tomatoes. Gard. Chron. **93**: 327, 1933.

Forty-six Annual Report of the Kentucky Agricultural Experiment Station for the year 1933. Part I, 69 p., 1934.

This report contains the description of an experiment on tobacco mosaic (green and yellow) transmission by trash left in the soil.

Mayagüez 28. Puerto Rico Agric. Expt. Sta. Ann. Rept. **1933**: 7–10, 1934.

This variety proved to be highly resistant to mosaic. In a survey of several fields, very seldom more than 3 or 4 per cent infection was found on Mayagüez 28 in plots adjoining heavily infested fields.

Legislative and administrative measures. Madagascar and Dependencies. Internt. Bull. Plant Proct. 8(3): 56, 1934.

Comoso Islands and Madagascar, have been declared infected by sugar-cane mosaic and importation of canes from them prohibited.

Experiment Station notes. South African Sugar Journ. **18**(**1**): 11–13, 1934.

Brief notes describing the disease and a warning to farmers in varietal susceptibility.

Tobacco growers. Important notice. The "Kromnek" disease of tobacco. Rhodesia Agric. Journ. **21**(1): 9–10, 1934.

Brief notes describing the disease and a warning to farmers in order to prevent an epidemic.

Archibald, E. S.
Report of the acting Dominion botanist. Dom. Expt. Farm. Ann. Rpt. **1920**: 58–64, 1921.

Notes on bean mosaic on page 62.

Artschwager, Ernst F[riedrich]
Anatomy of the potato plant, with special reference to the ontogeny of the vascular system. Journ. Agric. Res. **14**(6): 221–252, 1918.

The aim of this study was to make more accurate the knowledge regarding the normal structure of the potato plant. The present work was undertaken in order to make possible a more rapid progress in the study of several important potato diseases such as leaf roll.

Ashby, S[ydney] F[rancis]
Transmission of two diseases caused by infective viruses. Trop. Agric. (Trinidad) **3**: (5)98, 1926.

In this paper the author makes a brief review of the work done on bunchy top of banana occurring in Australia and curl or rosette of peanuts in Tanganyika Territory.

Atanasoff, D[imitr]
(A new virus disease). Yearbook Univ. Sofía, Fac. Agric. **11**: 49–70, 1932.

(Bitter pit of pome fruits is a virus disease). I Contribution. Univ. Sofía. Yearbook. Fac. Agric. **13**: 1–8, 1934.

The author states that an extensive survey of apple orchards and nurseries made during the summer of 1933 showed that bitter pit of apple, pear and quince is a widely spread malady in Bulgaria. Based on observations and graft experiments the author believes himself justified in concluding that bitter pit of pome fruits is caused by a virus or a group of viruses.

Old and new virus diseases of trees and shrubs. Phytopath. Zeitschr. **8**: 197–223, 1935.

Virus disease of citrus. Yearbook Univ. Sofía. Fac. Agri. 1934–35, **13**: 1–42. 1935.

This paper is a discussion of an infectious chlorosis which the author believes to be the same as "mal secco" and blight, or withertip (not same as *Gloeosporium limitticolum*), crinkly leaf, spot mosaic, zonate chlorosis, or ring blotch. The author believes all these diseases to be due to viruses. He also suspects that Reichert's little leaf, some of Shamel's bud selections, leprosis, corticosis, brown spot, peteca, endoxerosis and membranosis may be due to viruses.

Mosaic disease of drupaceous fruit trees. Yearbook Univ. Soiía, Fac. Agric., 1934–35, **13**: 9–42, 1935.

This paper is a discussion of chlorosis, variegations, mosaics and similar symptoms on these fruits which have been reported from various parts of the world but rarely attributed to viruses. The author reports cross-inoculation experiments and says: "The mosaic disease of the various stone fruits is intertransmissible and can easily be communicated from diseased to healthy trees by budding. Under natural conditions it is spread by the plum aphid (*Anuraphis padi*)".

Austin, M. D., & Martin, H.

The incorporation of contact insecticides with protective fungicides. Potato field trials 1930–1932. J. S. E. Agric. Coll. Wye. No. **32**, p. 49–58, 1922.

Report of trials in which nicotine or pyrethrum was incorporated in the blight spray with the purpose of checking aphids on potatoes. The aphids are usually carriers of virus diseases. The results were successful.

Badami, V. K., & Venkata Rao, M. G.

A preliminary report on the varieties of *Santalum album* in Mysore. Mysore Sandal Spike Investigations Committee. Bull. 1, 1930.

Bailey, M. A.

Leaf curl disease of cotton in the Sudan. Empire Cotton Growing Rev. **11**(4) : 280–288, 1934.

Data in regard to spread and varietal resistance of leaf curl disease of cotton.

Baker, R. E. D.

Maize stripe disease. Trop. Agric. (Trinidad). **10**(8) : **221**, 1933.

Record of a disease of sorghum which resembles that on corn. It was experimentally transmitted by the leafhopper *Peregrinus maydis* from maize to sorghum with the production of symptoms resembling those on sorghum in the field. It was concluded that the two diseases are identical.

————————

Stripe disease of maize. Trop. Agri. (Trinidad). **10**(12) : 352, 1933.

A brief record of experiments which demonstrated that this disease is due to a virus and that it is not a stigmonose disease.

Ball, E[lmer] D[arwin]

The leafhopper of the sugar beet and their relation to the "curly top" condition. U. S. Dept. Agri. Bur. Ent. Bull. **66**: 33–52, 1909.

Baribeau, [Charles Henri] Bernard

A disease of the potato. Spindling tuber. Quebec Soc. Proct. Plants. 23d & 24th. Ann. Rept. **1930–32**: 199–200, 1932.

Popular.

Barton-Wright, E[ustace], & McBain, Alan

Possible chemical nature of tobacco mosaic virus. Nature 132 (3348) : 1003–1004, 1933. (Trop. Agric. (Trinidad) **11**(4): 101–102, 1934.)

Annotated in the bibliography page 41.

————————, **Cockerham, G., & McBain, Alan**

Rept. Director of Res. Scottish Soc. Res. in Plant Breeding Ann. Gen. Meeting 26th July, p. 15–17, 1934.

Report of the results obtained so far in regard to this type of work done by the authors.

Baudys, E[duard]

Fytopatologické poznámky VIII (Zarok 1932). Phytopathological notes VIII (for 1932). Ochrana Rostlin **13**(3–4): 90–102, 1933.

These notes are mainly on virus diseases of several plants, among which he mentions a case of potato mosaic on tomato as a record in south Moravia; he also reports the occurrence of mosaic on red clover and dahlias. This prevalence of mosaics is attributed in part to drought conditions and lack of proper fertilization.

Bawden, F. C.

Studies on a virus causing foliar necrosis of the potato. Proc. Roy. Soc. London. **B. 116**(799): 375–395, 1934.

The author describes a virus which he designates as "D". It is the cause of a "foliar necrosis" and in some varieties a "top necrosis". However, "top necrosis" may be due to other viruses. The virus also attacks white burley tobacco, tomato, *Nicotiana glutinosa*, and *Datura stramonium*. He failed to secure successful transmission by insects.

Beauverie, J[ean-Jules]

Action du parasite sur la résistance du chondriome-plastidome sa fragilisation et l'altération de a structure cellulaire. Proc. Int. Cong. Plant Sci. Ithaca 1926. **2**: 1299–1311, 1929.

A study of cell contents. Does not discuss virus diseases but is of interest to students of the subject.

Beale, Helen Purdy see **Purdy Beale, Helen**

Bechhold, H., & Erbe, F.

Die Biologie der Kartoffel XVI. Mitteilung. Studie über die Kolloidstruktur der Kartoffelknolle. (The biology of the potato. XVI. Studies on the colloid structure of the potato tuber). Unterschiede zwischen Vital-und Abbauknollen. Arb. Biol. Reichsanst. Land u. Forstw. Berlin **20**: 111–139. 1932.

———— & Schlesinger, M.

Grösse von Virus der Mosaikkrankheit der Tabakpflanze. (The size of the virus of the mosaic disease of the tobacco plant). Phytopath. Zeitschr. **6**(6): 627–631, 1933.

After detailed and prolonged experiments the authors reach the conclusion that the size of particles of tobacco mosaic are about 50 $\mu\mu$ in diameter. They compared it with several animal viruses.

————

Enzyme oder Lebewesen? (Enzyme or living entity?.) Kolloid Ztschr. **66**(3): 329–340, **67**(1): 66–79, 1934.

The author discusses the enzymatic conception of the viruses. He is against it and in favor of the "living entity" theory.

Beckwith, C[harles] S[teward]

False blossom. Amer. Cranberry Grow. Assoc. Proc. Ann. Meet. **65**: 25–27, 1935.

Bell, A[rthur] F[rank]

Report of the Division of Entomology and Pathology. Part of 34th Ann. Rpt. of the Bureau of Sugar Experiment Stations (Queensland, Australia) pp. 51–72, 1934.

A part of this report is devoted to diseases of sugar cane including tests to determine the effect of chlorotic streak on yields and a progress report on the dwarf disease and the Fiji disease.

Bennett, C[arlyle] W[ilson]

Plant-tissue relation of the sugar-beet curly-top virus. Journ. Res. Agric. **48**(8): 665–701, 1934.

This rather extensive study gives the author's observations in experimental work.

Properties of the sugar-beet curly-top virus. Phytopathology (title) **24**:(10): 1135, 1934.

Berkley, G[arven] H[ugh]

Recent advances in the study of tomato streak and mosaic. Canadian Hort. **58**: 58–59, 1935.

Occurrence of "spotted wilt" of tomato in Ontario. Scient. Agric. **15**(6): 387–392, 1935.

Account of this disease reported to have occurred in 1931 and studied in 1934. Symptoms are described and control measures suggested.

Bewley, W[illiam] F[leming] & Corbett, W.

Mosaic disease of the tomato. Expt. & Res. Sta. Nursery & Market Gard. Indust. Devel. Soc. Turner's Hill, Cheshunt, Hort. Ann. Rpt. **16**: 56–62, 1930.

In this report the authors describe the disease and its behaviour. Also the cultural practices by which the growing tip is removed inducing secondary infections. Two types of the disease are common—ordinary and aucuba mosaic. The last mentioned was transmitted to tobacco which shows symptoms very similar to those of Doli tobacco affected by the one known as Rotterdam B. disease.

Tomatoes: cultivation, diseases, and pests. Min. Agric. & Fish, Bull. **77**, 71 p., 1934.

Virus diseases of tomatoes are discussed in this bulletin.

Birkeland, Jorgen M.

Photodynamic action of methylene blue on plant viruses. Science n.s. **80**(2077) : 357–358, 1934.

Brief article in which the author reviews the work done on the subject in regard to animal viruses. Reports very briefly on an experiment with plant viruses of different types. In conclusion he states that from these experiments it would seem that in general, plant viruses are more resistant to the photodynamic action of dyes than are animal viruses or bacteriophages.

Bitancourt, A[gegislan]

O mosaico e "streak disease" (Mosaic and streak disease). Characas o Quintaes (Brasil) **34**(5)453, 1926.

Protozoarios do mosaico (Protozoa of mosaic). Rev. Agric. Piracicaba, Brasil **3**(1) : 37, 1928.

A criticism of the protozoan theory of sugar-cane mosaic as given by Averna-Saccá.

-------------, **& Grillo, H. V. S.**

A chlorose zonada uma nova doenca dos citrus. (A zonal chlorosis, a new citrus disease.) Arch. Inst. Biol. Sao Paulo **5**: 245–250, 1934.

Black, L. M.

The potato yellow dwarf disease. Amer. Potato Journ. **11**(6) : 148–152, 1934.

Potato yellow dwarf is transmissible by stem grafting. The clover leaf-hopper, *Agallia sanguinolenta* Prov. is the only vector known. The incubation period in the plant is variable; whether transmission was by grafting or by insect inoculation the incubation averaged 40 days. The virus overwinters in two or more ways: (1) in the potato tuber and (2) in the clover leafhopper or in some host other than the potato.

A mosaic on cabbage in Wisconsin. Phytopathology (Abstract) **25**(1) : 6, 1935.

Blattny, C[tibor Eugen Marie Karel]

Jde u mosaiky Revy Vinné o jediny virus? (Is only one virus involved in vine mosaic?) Ochrana Rostlin **13**(3–4) : 104–115, 1933.

Report of three year grafting experiments to study the nature of vine mosaic in Czechoslovakia. The results are given in tabular form,

they lead the author to believe that there are two different viruses in the mosaic of the vine occurring in his country.

The experiments indicate that this virus disease is distinct from "roncet".

Vertikalni rozsireni virovych chorob. (Vertical spread of virus diseases). Ochrana Rostlin **13**(3–4) : 145, 1933.

The author in a short note reports the spread of virus diseases up to an altitude of about 1,550 meters above sea level. Among those mentioned are potatoes, *Urtica dioica* and *Berberis vulgaris.*

Virové choroby Pelargonii (Virus disease of Pelargonium). Ochrana Rostlin **13**(3–4) : 145, 1933.

A short note reporting at least two virus diseases of pelargoniums in addition to leaf curl, existing in Czechoslovakia. Description of the diseases is given.

Mosaika na Celeru (*Apium graveolens*). (Mosaic of celery. (*Apium graveolens.*) Ochrana Rostlin **13**(3–4) : 145–146, 1933.

Brief note reporting for the first time celery mosaic in Czechoslovakia. The outbreak appeared to be correlated with the prevalence on the crop of the insect *Chlorita flavescens.* Celeriac planted in close proximity to diseased celery plants did not contract the disease.

Bodine, E. W.

Occurrence of peach mosaic in Colorado. Plant Disease Reporter **18**(10) : 123, 1934.

A severe outbreak of peach mosaic, first recorded from Texas, is reported from Mesa County, Colorado, where some of the orchards contain up to 100 per cent infected trees. Eradication work is in progress.

Bohme, R. W.

Das Vorkommen von Virosen auf dem Dahlemer Versuchsfelde. (The occurrence of viruses on the Dahlem experimental field). Arb. Biol. Reichsanst. für Land-und Forstwirtsch; **21**(1) : 1–58, 1934.

Continuation of previous experimental work. In this paper the author gives a very comprehensive account of his observations on the nature of the virus diseases of potatoes.

Bokura, U.

(Dwarf disase of rice plant). Journ. Japanese Agric. Soc. **593** : 56–59, 1930.

Bolley, H. L.

Methods of detecting mosaic being studied in North Dakota. Potato News Bull. **1**(10): 220–221, 1930.

Popular.

Boning-Seubert, E.

Die Mosaikkrankheit der Gurken. (The mosaic disease of cucumber). Prakt. Blätter für Pflanzenbau & Pflanzenschutz **11**(9–10): 291–321, 1933–34.

A popular account based on American investigations and literature.

Booberg, K. G.

Over het gebruik van gelestrepenziek plant material. (On the use of yollow stripe-diseased planting materia). Arch. voor Suikerind. Nederl.—Indie, Deel I. **42**(10)): 319–331, 1934.

This article is a study of statistical data on the transmission of sugar-cane mosaic disease, well tabulated and discussed. The author makes distinction on "liability" to infection and "susceptibility" in connection with mosaic. He states that, due to the use of resistant POJ–2878 variety, sugar-cane mosaic became a minor problem, but on account of the recent planting of very susceptible varieties it has become prominent once more.

Bouffil, F.

Contribution á l'étude de deux maladies de l'arachide. I. H. (Contribution to the study of two peanut diseases. I. II.) Bull. Mens. l'Agence Econ. l'Afrique Occid. France **14**: 3–6, 1933.

Bouriquet, G.

Les maladies du Tabac á Madagascar. (Tobacco diseases in Madagascar.) Ann. Cryptog. Exot. **7**(2): 97–112. 1934.

This report includes some tobacco virus diseases.

Boysen-Jensen, P.

Die Stoffproduktion der Pflanze (Blattrollkrankheit). Jena, 108 p., 1932.

Brandes, E[lmer] W[alker] & Coons, G[eorge] H[erbert]

Beet crop problems: science helps find the answers. Facts About Sugar **29**(3): 83-85, (4): 117–121, 1934.

In this account sugar-beet curly top disease is discussed.

Brehmer, G[ustav] von

Über die Viruskrankheiten verschiedener Kulturpflanzn. (Virus

diseases of different cultivated plants). Rapp. 2 Congr. Intern. Pathol. Comp. Paris **1**: 360–362, 1931.

Sur les maladies á virus de diverses plants cultivées. (On virus diseases of different cultivated plants.) Compt. Rend. 2 Congr. Int. Pathol. Comp. Paris **2**: 433–434, 1931.

Brierley, Philip

Dahlia mosaic and its relation to stunt. Canada, Flor. **29**: 4 9, 16, 1934.

Streak, a virus disease of roses. Phytopathology (Abstract) **25**(1): 7, 1935.

Symptoms of rose mosaic. Phytopathology (Abstract) **25**(1): 8, 1935.

Brierley, W[illiam] B[roadhurst]

Discussion on "Ultra-Microscopic Viruses". Proc. Roy. Soc. **B 104**: 558–559, 1929.

The author states that "the plant pathologist does not attach anything like as much importance to ultra-microscopic characters as the animal pathologist". He emphasizes the importance of the studies on insect transmission and the differences in strains of viruses.

Brown B[enjamin] A[rthur]

Mosaic versus leafroll. Amer. Potato Journ. **3**(4): 121–122, 1926.

Popular.

Bushnell, John

Do potato varieties degenerate in warm climates? Amer. Potato Journ. **5**(8): 245–246, 1928.

Answered in the affirmative although the author does not deny that virus diseases are important factors.

Butler, E[dwin] J[ohn]

Views on the "spike" disease in sandalwood. Reported by M. Muthannab. 6 p. 1904.

A review of the subject.

Some relations between vegetable and human pathology. Trans. Roy. Soc. Trop. Med. Hyg. **15**: 203–211, 1922.

Includes a comparison of plant and animal virus diseases.

Resolution passed by the Fifth International Botanical Congress, Cambridge, England, August 1930. Phytopath. Zeitschr. 4(2): 225–226, 1931.

This resolution was passed with tentative suggestions for activities of the International Committee on the naming and description of plant virus diseases.

Butler, O[rmond Rourke]

How often should the potato grower renew his stock? New Hampshire Agric. Expt. Sta. Circ. **45**, 8 p., 1934.

Popular suggestions to farmers giving information in regard to potato leafroll and mosaic diseases.

Caldwell, John

The movement of the virus agent in the plant. Deux Cong. Int. Path. Comp. Paris 1931. **II** Comptes Rend. et Comm. p. 480, 1931.

A brief note.

Possible chemical nature of tobacco mosaic virus. Nature **133** (3353): 177, 1934.

The author agrees with Barton-Wright and McBain findings of tobacco-mosaic virus in the crystalline part of the mixed phosphate element precipitated from the juice of inoculated *Nicotiana glutinosa* plants, but the amount declines progressively with each successive washing. He gives many data of his observations and conclusions. The virus in the crystals is nothing more than an impurity and the absence of any specific relation between the crystals and the virus is readily demonstrated.

The control of virus diseases of the tomato. Journ. Min. Agric. **41**(8): 743–749, 1934.

Popular account in regard to virus diseases of tomato in greenhouses. Gives brief descriptions of tomato mosaic, streak, spotted wilt, aucuba mosaic and ''double virus'' streak. Gives some data on transmission and recommendations for control.

On the interactions of two strains of a plant virus: experiments on induced immunity in plants. Proc. Roy. Soc. **B117**: 120–139, 1935.

Report of experiments with yellow mosaic of tomatoes.

Spurious cucumber "mosaic" due to copper poisoning. Journ. Min. Agric. Gt. Brit. **42**: 97–98, 1935.

Popular.

The physiology of virus diseases in plants. VII. Experiments on the purification of the virus of yellow mosaic of tomato. Ann. Appl. Biol. **22**(1): 68–85. 1935.

This paper gives the results of experiments. The author did not find any evidence that the virus could be recovered in a crystalline form. Viruliferous material always contained traces of organic nitrogen. The virus is active over a wide range of pH from 2.0 to 10.5.

Calinisan, Melanio R.

A suspected "mosaic" of Abacá in the Philippines. The Philippines Journ. Agric. 5(4): 255–256, 1934.

A record of a new disease.

Campbell, A. H.

Virus diseases of Dahlias. The Dahlia Yearbook **1934**: 14–23, 1934.

Descriptions of dahlia mosaic, streak and spotted wilt. The paper gives practical directions for their control.

Carne, W[alter] M[illard,] & Martin, D.

Apple investigations in Tasmania: miscellaneous notes. Journ. Australian Council Sci. & Indus. Res. 7(4): 203–214, 1934.

1. The virus theory of bitter pit. 2. Crinkle in apples. 3. Watercore breakdown. 4. The correlation of refractive index and freezing point depression.

Carpenter, C[larence] W[illard]

Pathology: Ann. Rpt. Comm. in charge of the Expt. Sta. for the year ending September 30th, 1933. Proc. H. S. P. A. 53 Ann. Meeting 1934, p. 24–35, 1934.

In an experiment the author kept mosaic leaves of sugar cane of variety Ba–11569 for 10 minutes at a temperature ranging from 52° to 56° C. and attempts were then made to transmit the disease from these leaves to healthy ones of the same variety using Seín's needle prick method; the results of these inoculations indicated that the thermal death point of the virus lies btween 53° and 54° C. Knife transmission of mosaic has been conducted with susceptible varieties. Chlorotic streak developed rapidly on sugar-cane fields after floods during storms. Studies of the phenomenon are in progress.

Carter, Walter, & Crawford, R[aymond] F[rank]

Eutettix tenellus (Baker) as a factor in the production of nicotine for insecticidal purposes. Journ. Econ. Ent. **22**(1): 158–160, 1929.

Report of observations made by the writers including their observations in regard to curly-top of beets.

Castolla, F. de

Court-noué—a mysterious vine disease. Journ. Dept. Agric. Victoria **32**(6): 298–301, 1934.

The author states that recovery from this disease is more common in Australia than in Europe. Discusses the different theories about the real nature of this disease with special reference to the recent paper by Viala and Marsaics attributing the majority of the cases to the fungus, *Pumilus medullae*.

Cation, Donald.

Peach mosaic. Phytopathology **24**(12): 1380, 1381, 1934.

The disease was transmitted by budding although the buds died. The symptoms appear during low temperatures of 40° to 50° F. but not at 75° F.

Cayley, Dorothy M.

Panachure infectieuse (breaking) des tulipes. (Infectious variegation (breaking) of tulips.) Deux. Cong. Int. Path. Comp. Paris 1931. **II** Compt. Rend. et Comm. p. 446–447, 1931.

A brief review.

Chamberlain, E. E.

Tomato mosaic. Its appearance, cause, and preventive treatment. New Zealand Journ. Agric. **48**(6): 344–351, 1934.

Report on the occurrence of tomato mosaic (ordinary and aucuba) in New Zealand. General discussion on the subject of a semi-popular character.

A virus disase of strawberries in New Zealand. New Zealand Journ. Agric. **49**(4): 226–231, 1934.

It is stated that a virus disease is one of the causes of degeneration of strawberries in New Zealand. The author gives description of the symptoms of the disease. The aphis *Capitophorus fragariae* Theo is the vector.

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Narrow-leaf a virus disease of tomatoes. New Zealand Journ. Agric. **49**(5) : 257–263, 1934.

A preliminary paper.

Chandler, W. H., Hoadland, D. R., & Hibbard, P. L.
Little-leaf or rosette of fruit trees. II Effect of zinc and other treatments. Proc. Amer. Soc. Hort. Sci. **29**: 255–263, 1933.

Chester, Kenneth, S.
Specific quantitative neutralization of the viruses of tobacco mosaic, tobacco ring spot, and cucumber mosaic by immune sera. Phytopathology **24**(11) : 1180–1202, 1934.

Brief review of other workers on the subject and the literature so far. A detailed account of his studies and observations.

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Serological evidence in the study of the relationships of certain plant viruses. Phytopathology (Abstract) **25**(1) : 10, 1935.

Chittenden, F. J.
Mosaic disease of narcissi. Daffodil Year Book, Roy. Hort. Soc. **1933** : 72–73, 1934.

Christoff, Alexander [Cristow.]
Mosaikkrankheit oder Virus-Chlorose bei Apfeln. Eine neue Virus-Krankheit. (Mosaic disease or virus chlorosis in apples. A new virus disease.) Phytopath. Zeitsch. **7**(6) : 521–536, 1934.

Reports a new virus disease of apples and other fruit trees, including pear, quince, apricot, peach and plum. Of occurrence and observations made since 1930 by the author in Bulgarian nurseries. The author also states that he has observed the occurrence of mosaic on a large number of other Rosaceous hosts besides those mentioned above; almond, cherry (*Prunus cerasus, P. avium*), and wild rose. Control measures are suggested.

Clinch, Phyllis, & Loughnane, James B.
A study of the crinkle disease of potatoes and its constituent or associated viruses. Sci. Proc. Roy. Dublin Soc. n. g. **20** (27–40) : 567–596, 1933.

Descriptions of several virus diseases. A thorough account of the authors' observations based on experiments in intertransmission of these virus diseases artificially and by means of the aphid *Myzus persicae*.

Clinton, G[eorge] P[erkins] & McCormick, Florence, A.
Tobacco mosaic. Connecticut Agric. Expt. Sta. Rpt. of Tobacco Station at Wuilsor, Tobacco Stat. Bull. **10**: 75T–82T, 1928.

A popular general account discussed in the following topics: effect on host, cause?, known facts of mosaic and preventive measures.

Conceicao, C.
O mosaico da canna (Cane Mosaic), Fazenda Fluminense, Brasil, **1**(16): 18, 1930.

Conners, I. L.
Thirteenth annual report of the Canadian plant disease survey 1933. p. I–IX, 1–75, 103–128, 1934.

This report contains notes on false blossoms of cranberry.

Cooley, L. M.
Control of raspberry viruses. Amer. Nurseryman **61**(7): 7, 1935.

Source of raspberry mosaic infections and how to get rid of them. Proc. New York State Hort. Soc. **80**: 273–277, 1935.

Coombs, J.
Black currant reversion. Gloucestershire Farmer **3**: 83–87, 1935.

Costa Lima, A[ngelo] M[oreira]
Sobre o mosaico da canna. (About sugar-cane mosaic). Characas e Quintaes (Brasil) **34**(1): 30, 1926.

Costantin, Julien [Noel], Lebard, P[aul] & Magrou, J[oseph]
Influence du séjour en montagne sur la productivité de la Pomme de terre. (Influence of mountainous regions on the productivity of potato). Compt. Rend. de Séances de l'Acad. Sci. **193**: 902, 1931.

Précocité productive et resistance a la dégénérescence. (Premature production and resistance to the degeneration). Compt. Rend. Acad. Agric. France **18**: 661–665, 1932.

A review of work of others on sugar cane.

Selection practique da la Pomme de terre en plains et en montagne en vue de combattre la dégénérescence. Conférence faite le 20 octobre (1932) devant la Ligue nationale du lutte contre les enmemis des cultures, 5 avenue de l'Opéra,

á Paris. (Practical selection of potatoes in low and high lands with the view of fighting degeneration. Conference given on October 20, 1932, before the National League against the enemies of crops. Held. at 5 Opera Ave. Paris). 1932.

Évolution de nos conceptions sur la dégénérescence et la symbiose. (Evolution on our conceptions of the degenerations and symbiosis). Ann. Sci. Nat. Bot. **10**(15) : 1–53, 1933.

Sereh disease of sugar cane receives some attention in this paper, but there is very little on the other virus diseases.

Cowland, J. W.

Gezira Entomological Section, G. A. R. S. Final Report on experimental work, 1932–33. Gezira Agric. Res. Serv. Ann. Rpt. for the year ended 31st December 1933, p. 107–125, 1934.

Studies of transmission of cotton leaf curl disease by means of the white fly *Bemisia gossypiperda* on cotton plants and other host plants.

Crew, F. A. E., & Lamy, R.

Autosomal colour mosaics in the Budgerigar. Journ. Genetics **30**: 235–241, 1935.

Cristinzio, M.

La "necrosis" del cuore" dei tubori di Patata. (Heart necrosis of potato tubers). Ricerche, osservazioni ed divulgazioni fitopatologich per la Campania ed il Mezzogiorno (Portici) R. Lab. Pat. Veg. Portici **3**: 3–17, 1934.

Report of tests made on Bohms potato variety affected with heart necrosis. Histological examinations were made and the observations reported. The author attributes the disease to the action of a virus in a localized form. Classified according to Quanjer under category V or pseudo-net necrosis.

Cunningham, H. S.

The lily situation. Bermuda Dept. Agric. Bul. **8**: 12–13, 21–23, 1929.

Visited greenhouses in New York. Found the plants grown from Bermuda bulbs of *Lilium harrisii* superior to those grown from other stock. This is due to eradication of disease (mosaic). The mosaic is more marked in low than in high temperatures.

Currie, J. F.

The production of high-grade seed potatoes in North Wales. Journ. Min. Agric. **40**: 316–326, 1933.

Curzi, M[ario]

Propieta e natura di virus delle piante. (The properties and nature of plant viruses.) Rev. di Biol. **16**(2): 335–352, 1934.

Discussion on the subject under the three theories that have been advanced trying to explain the nature of plant viruses i. e. (1) autocatalytic, (2) microbial, and (3) ultra-microbial.

Le malattie da virus delle piante. (Virus disease of plants.) Testo della Confrenza tenuta alla riunione dei Tecnici Agricoli Fasciti a Udine il 28 marzo 1933. A–XI ampliato e corredato delle documentazione bibliográfica, p. 3–51, 1934.

Daikuhara, G.

(On dwarf disease of rice plant.) Journ. Tokyo Chem. Soc. **25**: 215–253, 1904. (Imp. Agric. Expt. Sta. Bull. **29**: 163–193, 1904. Journ. Japanese Soc. Agric. **255**: 4–8, 1902.)

Dana, B[liss] F.

Progress in Investigation of curly top of vegetables. Ann. Meeting, Oregon State Hort. Soc. Proc. **49**: 95–99, 1934.

Popular review of work started in 1928.

The curly-top disease of vegetables in the Pacific Northwest. U. S. Dept. Agric. Bur. Plant Ind. (Mimeograph) 4 pp.

Appears to be a progress report but gives suggestions for control in tomatoes.

Davidson, J. & Bald, J[ames] G[rieve]

Description and bionomics of *Frankliniella insularis* Franklin (*Thysanoptera*). Bull. Ent. Res. **21**(3): 365–385, 1930.

Davis, R[obert] L[esley]

Mayagüez sugar-cane varieties resistant to mosaic. Intrn. Sugar Journ. **34**(407): 434–435, 1932.

Brief review.

Report of the plant breeder. Puerto Rico Agric. Expt. Sta. Ann. Rpt. **1931–32**: 13–22, 1933.

Report of the results of mosaic-resistant varieties and their distribution in the island.

Sugar-cane variety POJ 2878 in Puerto Rico. Puerto Rico Agric. Expt. Sta. Bull. **35**, 45 p., 1934.

Data on yields of POJ 2878 sugar-cane variety planted in some district to replace B.H. 10(12) as mosaic-resistant variety.

Demandt, E.

Samenvatting van de resultaten der vakkenproeven van oogstjaar 1934 over verschillende onderwerpen. (Summary of the results of plot tests during the harvest year 1934 on various lines of investigations.) Arch. Suikerindus. Neder.—Indië, Deel **2**(26) : 937–946, 1934.

This report contains a great deal of data in regard to yields of mosaic-diseased sugar cane.

Demaree, J. B., Fowler, E. D., & Crane, H. L.

Control of pecan rosette with zinc sulfate. Proc. 28th. Ann. Cont. Southeastern Pecan Growers' Assoc. p. 29–37, 1934.

This is not a virus-disease paper, but as pecan rosette has been considered by some investigators as a disease belonging to the virus group and the symptoms are so similar we decided to include this article which might be of interest to students of the subject.

Desai, S. V.

Studies on the nature of the causative agent of the mosaic diseas of tomatoes. Indian Journ. Agric. Sci. **3**(4) : 626–638, 1933.

Description of experiments to study the nature of the virus of tomato mosaic disease.

Dieselben

Die Blattrollkrankheit und unsere Kartoffelernten. (The leaf roll disease and our potato crop.) Arbt. d/D.L.G. Heft 190, 1911.

La maladie de l'enroulement des pommes de terre. (The leaf roll disease of potatoes.) Ann. Serv. Epih. **6**: 1919.

Dix, W[alter]

Ein Beitrag zur Frage des Abbaues der Kartoffel. (A contribution to the problem of degeneration in the potato.) Landb. Jb. **80**(5) : 769–809, 1934.

A detailed account of the experiments conducted by the author at the Kiel Experimental and Plant Breeding Institute. He attributes this disorder to alcohol formation in the tuber with consequent respiratory disturbance and not, at any rate in the first place to virus infection.

Dobrozrakova, T. L.

Neparzituye zabolevanica Kartofelia. (Non parasitic diseases of potatoes.) Bolezni Rastenu. Morbi Plantarum **16**(2): 121–135, 1927.

Report of observations and studies of mosaic, aucuba, leafroll, crinkle, curly dwarf and necrosis of the parenchyma and the vascular tissues. The effect of temperature on these diseases is given under Leningrad conditions. These studies were based on tuber inoculation which were preferred to top inoculations.

Dodds, H. H., & Fowlie, P.

The effect of streak disease on the yield of Uba Cane. Part II. South African Sugar Journ. **18**(4): 241, 243, 1934.

Report on yields of streak disease of sugar cane. Resistant varieties are recommended as means of control.

Doolittle, S[ear] P[olydore], & Sumner, C. B.

Probable occurrence of Australian spotted wilt of tomatoes in Wisconsin. Phytopathology **24**(8): 943–946, 1934.

Brief account of a disease of tomatoes occurring in Wisconsin, which in behaviour, nature and symptoms is very similar to the Australian spotted wilt.

Dover, C. & Appanna, M.

Studies on insect transmission. Entomological investigations on the spike disease of sandal. (20). Indian For. Rec. **20** (1): 1–25, 1934.

Data of experimental evidence in insect transmission of spike disease of sandal.

Insect transmission of spike disease. Indian For. **40**(7): 505–506, 1934.

The author reports the failure to transmit spike disease of sandal by means of *Moonia albimaculata*. He is unable to accept the statement regarding the complete recovery of the ''infected'' plants.

Drake, C. J., Martin, J. N., & Tate, H. D.

A suggested relationship between the protoplastic bridges and virus diseases in plants. Science **80**(2067): 146, 1934.

The authors base their conclusion in their studies of yellow dwarf of onions. They suggest that the plasmodesma serve as protoplasmic bridges in the intercellular movements, not only of solutions and other substances of various kinds which have to do with the normal functions of the plant, but also of viruses and other disease-producing agents as suggested by Samuel.

Dubois, P.

Maladies de dégénérescense de la pomme de terre. (Degeneration diseases of the potato.) La Vie Agric. & Rurale **20**: 187, 1922.

A discussion of mosaic, crinkle and leaf roll.

Ducomet, Vital

Les maladies de dégénérescense de la pomme de terre. (The degeneration diseases of the potato.) Rev. Hist. Nat. Appl. **3**(1): 274–283, 1922.

A discussion of leafroll, curly dwarf and mosaic as used in different countries.

————————, **& Diehl, R.**

La culture de la pomme de terre en montagne et les maladies de dégénérescence. (Potato cultivation in the mountains and degeneration diseases.) Compt. Rend. Acad. d' Agric. France **20**(7): 228–238, 1934.

From the writers' comparative observations they concluded that the influence of the "degeneration" diseases on yield was at least as marked at the higher altitude as at the lower. The symptoms were more sharply defined in the mountains. In some instances the activity of insect vectors of virus diseases was much greater in the low-lying localities.

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La culture en montagne et les maladies de dégénérescence de la Pomme de terre. (Mountain cultivation and degeneration diseases of the potato.) Ann. Agron. **4**(3): 355–372, 1934.

A more detailed account than the paper above by the same authors.

Dufrénoy, Jean

(Biochemical factors of local immunity in plants.) Rpt. & Proc. 10th Intern. Hort. Congr. 1932. Soc. Nat. Hort. France, Paris, 1933.

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Les maladies á virus. Rpt. & Proc. 10th Intern. Hort. Congr. 1932. Soc. Nat. Hort. France, Paris, 1933.

————————, **& Dufrénoy, M. L.**

Cytology of plant tissues affected by viruses. Phytopathology **24**(6): 599–619, 1934.

The authors discuss the subject and describe their observations in comparison with healthy material. A bibliography of 48 titles is appended.

-------------, & **Shapovalov, Michael**

Cytological changes in the callus of the graft union in connection with curly top in tomatoes. Phytopathology **24**(10): 1116–1118, 1934.

Brief description of observations made by the authors.

Un virus des Renonculacées transmissible au *Nicotina tabacum.* (A virus of Ranunculaceae transmissible to *Nicotiana tabacum.*) Comp. Rend. Soc. Biol. (France) **117**(30): 346–348, 1934.

Brief note reporting a virus of Peonia transmissible to tobacco.

Le zinc et la croissance de la Vigne. (Zinc and vine growth.) La Potasse **75**: 137–139, 1934.

Gives the successful results obtained in the application of zinc sulphate and potash in checking "court-noué" of the vine. This disease of obscure nature is regarded by some authors as of a virus origin and very frequently is cited in the virus-diseases literature.

L'immunité des plantes vis-a-vis des maladies á virus. (Plant immunity against virus diseases.) Ann. Inst. Pateur **54**: 461–512, 1935.

Duggar, B[enjamin] M[inge,] & Livingston, L. G.

The location and concentration of the virus of tobacco mosaic within the cells. Amer. Journ. Bot. (Abstract) **20**(10): 679, 1933.

-------------, & **Hollaender, A.**

Irradiation of plant viruses and of micro-organisms with monochromatic light. I. The virus of typical tobacco mosaic and *Serratia marcescens* as influenced by ultraviolet and visible light. II. Resistance to ultraviolet radiation of a plant virus as contrasted with vegetable and spore stages of certain bacteria. Journ. Bact. **27**(3): 219–256, 1934.

Detailed account of the experiments and description of the procedure, giving results obtained.

Thermal inactivation of some tobacco viruses: Standardization, technique and illustrative data. Phytopathology (Abstract) **25**(1): 15, 1935.

-------------, & **Mc Alister, D. F.**

Some factors affecting "Longevity" *in Vitro* of viruses of to-

bacco mosaic and of tobacco ring spot. Phytopathology (Abstract) **25**(1) : 15, 1935.

Earle, F[ranklin] S[umner]

Cane shortage coming. Facts About Sugar **22**(44) : 1057, 1927.

A brief note in which the author predicts a shortage of cane production in Cuba as a result of the spread of mosaic.

Eckart, C. F.

The Fiji disease. Hawaiian Planters' Rec. **3**(4) : 175–176, 1910.

Brief note warning the planters against the danger of importing plants and soil from Fiji. At that time the true cause of the disease was not known.

Emmerez de Charmoy, D[onald]d'

Nouvelle contribution a l'étude du streak. (A new contribution to the study of streak.) Rev. Agric. de L'Ille de la Réunion n.s. **39** : 193–202, 1934.

Results of experimental work. The author describes two forms of streak. One of them being destructive.

Erikkson, Jakob.

The mycoplasm theory. Is it dispensible or not? Phytopathology **11**(10) : 385–388, 1921.

This paper is devoted to the mycoplasm theory as applied to parasitic fungi, but at the bottom of page 388 the author states that he suspects "the occurrence of a mycoplasm symbiosis in the life cycle of several other plant pathogens". He gives a list of parasitic fungi and includes tobacco mosaic.

Esau, Katherine

Localization of symptoms during the early stages of curly-top infection in the sugar-beet. Phytopathology (Abstract) **24** (10) : 1144, 1934.

Autogeny of the phloem in sugar beets affected by the curly-top disease. Amer. Journ. Botany. **22**(2) : 149–163, 1935.

The virus causes phloem degeneration, but one or more of the primary sieve tubes differentiate before degenerations becomes perceptible. Pericycle or phloem parenchyma becomes hypertrophied and dies, that is primary hypertrophy and primary necrosis. Cells some distance from sieve tubes are stimulated to growth and division; that is hyperplasia. A large number of the hyperplastic cells undergo

changes characteristic of differentiating sieve tubes, develop slime bodies and plastids; and both slime bodies and nuclei degenerate. The cytoplasm is reduced in amount and the cell walls thicken.

Fawcett, G[eorge] L[orenzo]

El enrolamiento de las hojas de la tomatera. (Leaf rolling of the tomato plant.) Rev. Ind. Agric. Tucumán **20**(3–4): 49–54, 1924.

Agallia stricticollis, which transmits beet curly top in Argentine is capable of transmitting a disease of tomatoes resembling leaf roll if allowed to feed on tomatoes after feeding on diseased beet. Conclusions drawn from cage tests.

Fawcett, H[oward] S[amuel]

Is psorosis of *Citrus* a virus disease? Phytopathology **24**(6): 659–668, 1934.

Description of symptoms of psorosis appearing as a mosaic-like disease affecting young leaves of citrus which was discovered in May 1933. The author believes, based on experimental and observational evidence, that the disease belongs to the virus group.

Folsom, Donald

Important papers published during the past year on degeneration or virus diseases of the potato. Proc. Potato Assoc. Amer. p. 29–33, 1922.

The effect of difference in region upon the natural spread of potato degeneration diseases. Agric. Bull. Bermuda **4**(7): 5–6, 1925.

A résumé of paper by Schultz and Folsom in Journ. Agric. Res. 30(6): 1925.

Tuber-unit seed plots in Maine. 1925. Potato News Bull. **2** (8): 304–305, 1925.

Popular.

Is uniformity of potato seed certification rules possible and desirable. Amer. Potato Journ. **3**: 377–378, 380, 382, 1926.

Die Kartoffelanerkennung in den Vereingten Staaten von Nordamerica. (The certifying of seed potatoes in the United States). Illus. Landw. Zeitung **47**: 43–46, 1927.

A review of Folsom's work by Dr. H. W. Wollenweber.

Comparison of "healthy" Green Mountain Strains and tuber lines in Maine. Proc. of the 17 Annual Meeting of the Potato Asso. of America. December 1930.

Popular.

Potato virus diseases in 1932. Amer. Potato Journ. **10**(11): 224–233, 1933.

Review of recent American and European literature on potato virus diseases.

Potato virus diseases in 1933. Amer. Potato Journ. **11**(9) :235–242, 1934.

A summary of 133 papers. (1) An unusually large number of publications; (2) Naming and classifications of virus diseases far from solution; (3) Experimental transmission and field observations have given new light on insects; (4) Natural dissemination varies with location; (5) Knowledge of geographical distribution increasing; (6) Some German workers still claim that virus diseases are due to growing conditions; (7) Virus diseases are important factors in seed improvement; (8) Tuber-indexing impractical without growing the plants; (9) Scientific knowledge of physiology increasing; (10) Data on yields increasing; (11) Progress in seed plot studies; (12) Seed free from masked mosaic and streak increasing; (13) New data on many diseases; (14) Psyllid yellow not proved to be a virus; (15) Cause of Giant Hill unsolved; (16) Some but not all of internal discolorations due to a virus.

Fukushi, Teikichi

Plants susceptible to dwarf disease of rice plant. Trans. Sapporo Nat. Hist. Soc. **13**(3) : 162–166, 1934.

Report based on a cage and glass-tube experiments of attempted transmission of dwarf disease of rice plant to cultivated and wild grasses; hosts and the insect vectors are given.

(The relation between *Nepholettix apicalis* Motsch. var. *cineticeps* Uhler and dwarf disease of rice plant). Agric. and Hort. **9**: 669–676, 879–890, 1091–1094. 1934.

Studies on the dwarf disease of rice plant. Journ. Fac. Agric. Hapkaido Imp. Univ. **37**(2) : 41–164, 1934.

A most complete discussion of the subject in which the author gives the history and geographical distribution of the disease, a review of the literature, the symptoms and the results of his own

work. Intracellular bodies are always present in diseased rice, in wheat, rye, *Panicum miliaceum*, *Echinochloa crus-galli*, sub sp. *colona* var. *edulis* and *Alopecurus fulvus*, but were not found in the insects. *Nephotettix apicalis* Motsch. var. *cinticeps* Uhl. is the only vector. Some individuals are viruliferous while others are not. The progeny of infected insects may or may not be viruliferous while those from a cross between uninfective females and infective males are non-viruliferous.

(The earliest record of the insect-transmission of virus diseases.) Journ. Plant Protection. **22**(1): 38–45. 1935.

Gandrup, Joh.

Verslag over het jaar 1923 door Dr. W. H. Arisz. Med. Beosoekisch Proefstation **36**: 20, 1924.

Refers to "kroekoek and krekoh" which are probably the same as "Kroeppoek".

Garbowski, L[udwik]

Choroby virusowe Ziemniakow w okresie 1928–1932. (Virus diseases of potato during the period 1928–1932.) Prace Wydz. Chor. Tosl. Panstw. Inst. Nank. Gosp. Wiejsk. Bydgoszczy. **13**: 1–136, 1933.

Gardner, Max W[illiam] & Whipple, O. C.

Spotted wilt of tomatoes and its transmission by thrips. Phytopathology (Abstract) **24**(10): 1136, 1934.

------------, **Tompkins, C[hristian] M[ilton] & Whipple, O. C.**

Spotted wilt of truck crops and ornamental plants. Phytopathology (Abstract) **25**(1): 17, 1935.

Ghimpu, V.

Sur les maladies á virus de *Nicotiana* spp. en Rumaine. (The virus diseases of *Nicotiana* in Rumania). Compt. Rend. 2 Congr. Intern. Pathol. Comp. Paris, **2**: 453–456, 1931.

Giddings, N[ahum] J[ames]

Testing sugar beets for resistance to curly-top. Phytopathology (title) **24**(10): 1135, 1934.

Gigante, Roberto

Risultati di un espirienza sull ereditarieta della maculature interna dei tuberi di patata. (Results of an experiment on the hereditary nature of internal spotting of potato tubers). Boll. R. Staz. Pat. Veg. ns. **12**(3): 275–277, 1932.

Report of the results of an experiment with potato affected with a disease which resembles hereditary spotting. The plants did not show the symptoms of the disease but the tubers were affected. The condition is considered to be a virus disease due to the pseudo-net necrosis virus of Quanjer, and transmitted by *Myzus persicae.*

Nota preliminaire sulla "Necrosi del cuore" del tuberi di patata. (Preliminary note on the "heart necrosis of the potato tuber.) Boll. R. Staz. Patol. Veg. n. s. **13**: 155–159, 1933.

Un caso di elevata recettivitá per le malattie da virus presentato da piante di patata provenienti da riproduzione sessuale. (A case of high receptivity to the virus disease shown by potato plants produced by asexual reproduction.) Boll. R. Staz. Pat. Veg. **14**(3) : 334–338, 1934.

"The behaviour of potato cultures, sexually and agamically reproduced, against virus diseases is described. The plants obtained from seed have shown a great susceptibility to virus diseases in comparison with the plants obtained from tubers of the variety 'Bianca di Como'. It appears from this that in some cases it is easier and quicker to obtain an improvement from the selection made from tubers than with sexual reproduction."

Gilbert, A[lfred] H[olley]

Spindling-tuber. A new potato disease. Vermont Agric. Ext. Ser. Circ. **28**, 1923.

Popular.

Gladwin, Fred E.

A non-parasitic malady of the vine. New York (Geneva) Agric. Expt. Sta. Bull. **449**: 99–110, 1918.

Account of a disorder of the vine occurring in the experimental grounds. The author does not regard it as a virus disease, but its symptoms are characteristic of diseases belonging to this group.

Goes, O[scar] C[ampos]

O mosaico como factor de perturbacao economica. (Mosaic as a factor in economic perturbation). Est. Expt. Barreiros. Brasil, 1930.

Goidánich, G.

Ricerche sul "deperimento" dei Susini. (Researches on the plum wilt.) Boll. Staz. Pat. Veg. Rome, n.s. **14**(3) : 339–381, 1934.

This disease is not attributed to a virus by the author, but due to the similarity of the symptoms described for other phloem necrosis of virus origin we decided to include it.

Grainger, J[ohn]

Some economic aspects of virus diseases in potatoes. The Naturalist pp. 151–153, 1933.

This is a brief paper showing the heavy losses in the potato crop of England as a result of virus diseases.

Graber, L. F. & Sprague, V. G.

Alfalfa yellows. Science n.s. **78**(2026) : 385–386, 1933.

This disease is due to insect injury. It is mentioned here because the name "yellows" may mislead. Some persons who have not seen the paper may suppose that the disease is due to a virus.

Gram, Ernst

II Filtrabelsygdomme hos. Planter. (Filterable virus of plants.) Nordiske Jordbrugsforskeres Kongres i Oslo 1926, Nordisk Jordbrugsforakning Heft **4–7** : 681–685, 1926.

Gratia, André

Pluralité, heterogenetié, autonomie antigénique des virus des plantes et des bacteriophages. (Multiplicity, heterogeneity, antigenic autonomy of the virus of plants and bacteriophages.) Compt. Rend. Soc. Biol. **114** : 1382–1383, 1933.

Des analogies entre les virus des plantes et les bacteriophages; rapprochement avec les tumeurs. (Analogies among plant viruses and bacteriophages; comparison with the tumors.) Compt. Rend. Soc. Biol. **115** : 189–192, 1934.

A brief discussion from the medical viewpoint.

------------, **& Manil, P.**

Différenciation sérologique des virus X et, Y de la Pomme de terre chez les plantes-infectées ou portenses de ces virus. (The serological differentiation of the X and Y potato viruses among plants infected by these viruses or carriers of them.) Compt. Rend. Soc. Biol. **117**(31) : 490–492, 1934.

In continuation of previous work of the senior author they prepared sera from potatoes from different sources. The experimental results obtained are discussed.

Les complexes de virus des plantes et la méthode sérologique.

(The complexes of plant viruses and the serological method.) Compt. Rend. Soc. Biol. **117** (31) : 493–494, 1934.

Brief account of experimental results obtained in trying to separate the complex of virus by serological methods following the technique in vogue with certain bacteriophages.

————————, & **Manil, P.**

De quelques échecs de la méthode sérologique appliquée aux virus des plantes. (On some failures of the serological method applied to plant viruses.) Comp. Rend. Soc. Biol., Paris, **118** (4) : 379–381, 1935.

Report of the negative results in serological experiments with a differential view point. The authors ascribe such failures to the mixture of viruses with divergent antigenic properties.

Graves, C. E.

The spindle tuber disease in Irish potatoes. Bienn. Rept. Kansas State Hort. Soc. **39** : 146–148, 1928.

Popular.

Green, D. E.

The virus of spotted wilt in Gloxinias. Gard. Chron. **96** (2488) : 159, 1934.

Note reporting *Gloxinia speciosa, Vicia faba,* and *Convolvulus arvensis* as hosts for the tomato spotted wilt virus.

Gulley, A. G.

The results of legal efforts to remove peach yellows. Trans. Peninsula Hort. Soc. p. 73–75, 1896.

A discussion primarily of costs.

Gulyás, Antal

A dohánylevél elzalagosodása és a mosaikbetegség. Magyar Nemzeti Könyv-Debrecen p. 21–28, n. d.

Guyot, A. L.

Essais de lutte practique contre la chlorose de Pécher. (Test on the practical control of peach chlorosis). Rev. Path. Veg. & D'Ent. Agric. **13** : 66–69, 1926.

Hall, Frank H.

Some disappointing seed potatoes. New York (Geneva) Agric. Expt. Sta. Bull. **422**, (Popular Edition) 8 p., 1916.

This is a brief review of Bulletin No. 422 of the same institution, "Observations on some degenerate strains of potatoes", by F. C. Stewart.

Hamilton, M. A.

Further experiments on the artificial feeding of *Myzus persicae* (Sulz.) Ann. Appl. Biol. **22** (2) : 243–258, 1935.

This paper is not a discussion of virus diseases, but it is of interest because the insect is a vector of virus diseases.

Hansen, Henning P.

Inheritance of resistance to plant diseases caused by fungi, bacteria and vira. A collective review with a bibliography. Yearbook Roy. Veter. & Agric. Coll. Copenhagen, **1934** : 1–74, 1934.

Hansford, C[lifford] G[erald]

Annual Report of Mycologist 1933. Uganda Dept. Agric. Ann. Rpt. **1933** (2) : 48–51, 1934.

This report includes notes on a serious mosaic disease of *Phaseolus* sp. and soy-beans.

Harrenveld, Ph[ilippus] van

De bibitvoorziening bij de Java-suikerindustrie in verband met de Sereh of zeefvatenziekte. Meded. Proefst. Java Suikerindus. **5**, 33 p., 1917.

Harris, R. V.

Mosaic disease of the raspberry in Great Britain. I Symptoms and varietal susceptibility. Journ. Pomol. & Hort. Sci. **11** (3) : 237–255, 1934.

This is a progress report of several years' work and investigations on the symptomatology of raspberry mosaic in England.

The "degeneration" of the strawberry. Imp. Br. Fruit Prod. Tech. Communication **5** : 11–15, 1934.

This work includes four different articles. In the second paper yellow edge, crinkle and gold disease are briefly discussed.

Harrison, A. L.

The effect of mosaic on transpiration of the bean. Phytopathology (Abstract) **25** (1) : 18, 1935.

Hartish, J.

Stoffwechselphysiologische Untersuchungen über die Blattrollkrankheit der Kartoffelpflanze. (Metabolic and physiological investigations on potato leaf roll.) Planta **22** (5) : 692–719, 1934.

Continuation of previous work. The results obtained so far are surveyed and discussed. Results are given as to his observations on healthy and diseased plants in regard to the metabolic process of dextrine formation. A preliminar study of the effect of increased dextrin production on certain physiological processes, such as assimilation and respiration, has yielded promising results.

Heald, F[rederick] D[e Forest] & Burnett, Grover.

A virus disease of perennial *Delphiniums*. Bulletin Amer. Delphinium Soc. **2**(2) : 14–21. 1934.

This paper reviews the history of this disease, describes the symptoms and gives the results of inoculations of 16 species of wild plants.

Hill, Helen Deuss

A comparative study of certain tissues of Giant-hill and healthy potato plants. Phytopathology **24**(6) : 577–598. 1934.

The author gives her observations comparing healthy plants with giant-hill potato plants. In conclusion she states that the disorganizations observed in photosynthetic and conducting tissues of the giant-hill plants are of related order though of less degree than the disorganizations reported for plants affected with some other virus diseases.

Hino, I.

(Early important records on phytopathological science in the Orient). Agric. & Hort. **2** : 1223–1232, 1927.

List of plants susceptible to mosaic and mosaic-like diseases. Miyakaki Coll. Agric. & Forst. Bull. **5** : 99–111. 1933.

(Teratological ferns caused by a virus disease.) Journ. Japanese Bot. **10** : 377–380, 1934.

Hoggan, Ismé A[ldyth]

Two viruses of the cucumber mosaic group on tobacco. Ann. Appl. Biol. **22**(1) : 27–36. 1935.

This paper was prepared for the purpose of describing two viruses of cucumber mosaic group which may or may not have been described. (1) A yellow cucumber mosaic virus which appeared during experiments with tobacco mosaic. (2) A second virus on tobacco appears to belong to the same group but shows differences from cucumber mosaic virus.

Holmes, Francis O[liver]

A masked strain of tobacco-mosaic virus. Phytopathology **24** (8) : 845–873, 1934.

Account of a masked strain of tobacco-mosaic virus. The author gives description of symptoms and behavior of the disease.

Inheritance of ability to localize tobacco-mosaic virus. Phytopathology **24**(9) : 984–1002, 1934.

The author states that localization of tobacco mosaic virus in *Capsicum frutescens* was to be determined by a dominant Mendelian factor. He describes the effect of tobacco-mosaic virus in plants possessing this factor.

Increase of tobacco mosaic virus in the absence of chlorophyll and light. Phytopathology **24**(10) : 1125–1126, 1934.

Brief account of results obtained in laboratory experiment.

Hopkins, J. C.

Suspected "streak" disease of maize. Rhodesia Agric. Journ. **32**: 234–236, 1935.

Horne, W[illiam] T[itus]

Avocado diseases in California. California Agri. Exp. Sta. Bull. **585**, 72 p., 1934.

This bulletin on diseases in general contains a description of sun blotch (p. 4–6).

Hungerford, Cha[rle]s W[illiam]

Calico and russet dwarf disease of potatoes. Idaho Agric. Expt. Sta. Ann. Rpt. **1920**: 42, 1920. (Idaho Agric. Expt. Sta. Bull. **122**, 1920.)

Brief note on calico and russet dwarf disease of potatoes. This paper does not attribute the cause of the disease to a virus but suggests a bacterial origin.

Hutchins, Lee M[ilo]

Phony peach. A new and dangerous peach disease. Maryland State Hort. Soc. Proc. 34th Ann. Meeting 1932, p. 42–51, 1932.

Popular.

Hyslop, G. R.

Seed production in relation to mosaic diseases. Seed World **33**(13) : 22–24, 1933.

Popular.

Imai, Y.

Studies on the transmission of broad bean mosaic. Trans. Sapporo Nat. Hist. Soc. **13**(3) : 241–245, 1934.

Aphis rumicis, Macrosiphum pisi and *Myzus persicae* were found to be transmiters of mosaic of *Vicia faba*. Details are given of the incubation period. Needle inoculations were successful in transmitting the disease.

Ishikawa, T.

(The merit of Hatsuzo Hashimoto, the earliest investigator of dwarf disease of rice plant.) Journ. Plant Protect. **15**: 218–222, 1928.

Iyengar, A. V. Varadaraja

Conrtibutions to the study of the spike disease of Sandal. (*Santalum album* Linn.) Part XV. The role of plant acids in health and disease. Journ. Indian Inst. Sci. **16A** (13): 139–152, 1933.

The author describes methods by which he compared the composition of spiked and healthy leaves of Sandal. He gives also the composition of both according to his findings.

Contributions to the study of spike-disease of sandal (*Santalum album* Linn.) XVI. Distribution of arsenic in sandal wood treated with sodium arsenite. Journ. Indian Inst. Sci. **17A**: 131–139, 1934.

Deamination in virus-infected plants. Nature **135** (3409): 345, 1935.

This paper is a study of spiked sandal.

Jaggar, Ivan C. & Chandler, Norman.

Big vein, a disease of lettuce, Phytopathology **24** (11): 1253–1256, 1934.

This disease was observed by Jagger several years ago. The cause is not definitely known but the disease has some of the characters of the soil borne-mosaic of wheat.

Jivanna Rao, P. S.

Spike disease in sandal, I. The virus theory repudiated. 8p. Reprint from Hindu. Oct. 17, 1932.

The author repudiates the virus theory and supports the physiological theory. To support his point of view he gives a review of the literature and the studies of other workers so far.

Spike disease in sandal. II. Killing of trees condemned. 2p. Reprint from Hindu. Oct. 21, 1932.

Brief popular article. Discusses the nature of the disease and condemns the practice of killing trees.

Spike disease in sandal. III. Physiological cause explained. 2p. Reprint from Hindu. Dec. 16, 1932.

The author discusses briefly the physiology of spiked sandal.

Correspondence. Spike disease of sandal 2 p. Reprint from Madras Agric. Journ. **21**(4), 1932.

Brief notes explaining the physiological theory of spike disease.

Jochems, S[arah] C[amelia] J[ohannes]

Overzicht van de ziekten en plagen der Deli-tabak in het jaar 1931. Med. Deli-Proefst. 2 ser. **73**: 16–17, 1932.

Johnson, Howard W.

Nature of injury to forage legumes by the potato leafhopper. Journ. Agric. Res. **49**(5) : 379–406, 1934.

This paper is not strictly on virus diseases, but is of interest to students on the subject. The author makes some statements of particular interest as ''all available evidence indicates that the pathological symptoms caused by the potato leafhopper on forage legumes are not due to the transmission of a virus by this insect''. He inserts a detailed discussion of the pathological changes underlying the various pathological symptoms.

Johnson, James & Hoggan, Isme A[ldyth]

A descriptive key for plant viruses. Phytopathology **25**(3): 328–343. 1935.

The authors explain the desirability of some system for the classification based on characters of the viruses rather than on symptoms on host plants. They discuss the most important diagnostic characters and present a series of tables, the last one being a descriptive key.

Jöhnsen, Alfred

Zur Blattrollkrankheit der Kartoffel. (On the leaf-roll disease of potato.) Kartoffel Zeitsch. Kartoffelhanges **13**: 150, 1933.

Über die Reisigkrankheit der Rebe. (On the twig disease of the vine.) Der Deutsche Weinbau, **1913**(17–20) 10 p., 1933.

The author describes fully his experiments and observations which lead him to conclude that the disease under study is a true virus disease. He considers the disease to be due to the same cause as ''roncet'', ''court-noué'', and leaf curl in other countries.

Jones, Leon K[ilby]

Virus diseases of raspberries in Washington. Proc. Washington State Hort. Assoc. **28**: 279–284, 1932.

A survey giving brief statements concerning virus diseases on red and black raspberries.

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Red raspberry mosaic. Washington State Coll. Ext. Serv. Circ. **22**, 4 p., 1934.

A popular discussion of symptoms, cause, importance, distribution and control.

————————, **Anderson, E. J., & Burnett, G[rover]**

The latent virus of potatoes. Phytopath. Zeitsch. **7**(1): 93–115, 1934.

The authors give the results of their experiments and observations fully discussed and tabulated. They reach the conclusion that the latent or "healthy potato" virus of American workers is the same as X virus of English workers, while the veinbanding virus often associated with it corresponds to the Y virus of the English, and that Z virus is probably an attenuated form of the Y virus.

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Tobacco mosaic on spinach. Phytopathology (Abstract) **24**(10): 1142, 1934.

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The rate of spread of the veinbanding on potatoes. Phytopathology (Abstract) **24**(10): 1144, 1934.

Jordi, E.

Di Blattrollkrankheit der Kartoffel. (The leaf roll disease of potato.) Arbtn. d. Auskunftstelle a. d. Landw. Hochschule Riitti-Zollikofen, 1919.

Jorstad, I[van]

Melding om plantesykdommer i land-og hagebruket. VIII. Sykdommer pa Tomater og Agurkvekster. (Report on plant diseases in agriculture and horticulture. VIII. Tomato and cucumber diseases.) Landbruksdirektorens Arsmelding, Tilleg C, 55 p., 1934.

Notes on the symptoms, etiology and control of virus diseases of tomato and Cucurbitaceae of occurrence in Norway.

Karatchevsky, I. K.

(Virus diseases of tomatoes in the Crimea. A year of field observations and experiments. In virus diseases of plants in

the Crimea and the Ukraine) State Publ. Office for the Crimea, Simferopol p. 39–58, 1934.

Detailed descriptions are reported in this paper of the author's observations in regard to ''fruit woodiness'' of tomato and tobacco mosaic (fern leaf). It concludes with an account of wild host influence and control measures.

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(Biochemical studies of the ''stolbur'' disease of the tomato. In virus diseases of plants in the Crimea and the Ukraine.) State Publ. Office for the Crimea, Simferopol, p. 74–78, 1934.

''Stolbur'' is the local popular name for the ''fruit woodiness'' disease. After discussing the biochemical studies on diseased plants concludes that, based on Dunlap's attempt to classify virus diseases according to the C/N ratio in the diseased plants the result appeared to support the Russian researches in that tomato ''stolbur'' belongs to the ''yellows'' group of virus diseases rather than to the true mosaic group.

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Die Viruskrankeiten der Tomaten in der Krim. (The virus diseases of tomatoes in the Krim.) In Rischkov, V. L. Viruskrankheiten der pflanzn in der Krim und Ukraina. Forshungs Isnt. der Krim & Inst. f. Pflanzensch. der Ukraine, Krimisdat, p. 39–58, 1934.

Report of observations of the behavior and effect of tomato virus diseases.

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Biochemische Untersuchung der Tomatenfruch verholzung. In Rischkov, V.L. Viruskrankheiten der pflanzn in der Krim und Ukraina. Forshungs Inst. der Krim & Inst. f. Pflanzensch. der Ukraine, Krimisdat, p. 74–78, 1934.

Comparison of healthy and virus-diseased tomatoes in these biochemical studies.

Kawamura, T.

Historical review of X-body, with one example, 1934.

Kendrick, James B[lair]

Cucurbit mosaic transmitted by muskmelon seed. Phytopathology 34(7):820–823, 1934.

Based on controlled experiments made by the author it was found that cucurbit mosaic can be transmitted by muskmelon seed.

Keuchenius, P. E.

Waarneningen over Ziekten en plagen bij tabak, Med. Bosoekisch-Proefstation **14**: 12, 1915.

Refers to "Kroepoek" and "Knepoh" which are probably same as "Kroepoek".

Keur, John Y.

Studies of the occurrence and transmission of virus diseases in the genus Abutilon. Bull. Torrey Bot. Club. **61**(2): 53–70, 1934.

Detail report of the experiments conducted by the author in seed transmission and grafting of different species of *Abutilon*. The disease is transmitted by grafting and very rarely by seeds.

Klapp, E. L., & Spennemann, F.

Okologie und Abbau der Kartoffel. (Ecology and potato degeneration.) Pflanzenbau, Pflanzenschutz u. Pflanzenzucht **9**(8): 303–313, 1933.

Continuation of previous work done by the senior author. Discussion of theories in regard to degeneration and environmental effect.

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Strichelkrankheit und Schernabbau der Kartoffel. Versuch der Analyse eines Falls schwerer, fortschreitender Wuchsstörungen. (Streak disease pseudo-degeneration of the potato. An attempted analysis of a case of severe, progressive growth disturbances.) Pflanzenbau **11**(2): 67–68, 1934.

Report of four years' investigation on the study of the failure of certain potato varieties. The authors believe that it is due to the combined effects of adverse environmental conditions acting on an impaired constitution. They regard the influence of virus diseases, if present, of minor importance.

Klinkowski, M.

Der Kartoffelabbau und seine Diagnose. (Potato degeneration and its diagnosis.) Die Umschau **37**: 198–202, 1933.

Knowlton, George F[ranklin]

Beet leafhopper notes. Utah Acad. Sci., Arts & Letters **11**: 238–239, 1934.

This is not an article on virus disease, but is of interest to students on the subject.

Koch, James, & Johnson, James

A comparison of certain foreign and American potato viruses. Ann. Appl. Biol. **22**(1): 37–54, 1935.

Viruses were obtained from nine foreign countries and compared with American forms, with emphasis on mottle, ring spot and vein-banding viruses. Mottle and ring spot viruses were present in potatoes from all nine countries. Veinbanding was found in potatoes from six countries.

Köch, Karl

Aphid transmission of potato yellow dwarf. Phytopathology **24**(10) : 1126–1127, 1934.

Brief account of test to determine the vector of potato yellow dwarf disease, so far *Myzus persicae* Sulz. appears to be the active vector under field conditions.

Köhler, E[rich]

Die Viruskrankheiten der landwirtschaftlichen Kulturpflanzen. (The virus diseases of agricultural plants.) Mitt. Deut. Landw. Ges. **48**: 572–573, 1933.

Untersuchungen über die Viruskrankheiten der Kartoffel. III. Weitere Versuche mit Viron aus der Mosaik gruppe. (Investigations on the virus diseases of the potato. III. Further experiments with viruses of the mosaic group.) Phytopath. Zeitschr. **7**(1) : 1–30, 1934.

A rather lengthy, comprehensive, and fully tabulated account is given of the writer's further studies on the potato mosaic viruses M 23, H 19, R 77 and G. A.

Virus Krankheiten. In Sorauer's Handbuch der Pflanzenkrankheiten. 1. Band. 2. Teil. 6. Aufl. Berlin, pp. 329–511, 1934.

An extensive review of the subject and description of the diseases, arranged after the host plants.

Beiträge zum Studium des Kartoffelabbaus. Beobachtungen auf dem Dahlemer Versuchsfelde der Biologischen Reichsanstalt. (Contribution to the study of potato degeneration. Observations on the Dahlem experimental field of the National Biological Institute.) Landw. Jahrb. **79**(2) : 205–217, 1934.

The author observed that the Aphis, *Myzus persicae,* from peach trees transmitted leaf roll from diseased to healthy potato plants to the extent of 100 per cent. He described the symptoms produced by different viruses experimentally transmitted.

Ueber die blattrollkrankheit und andere abbouursachen. Kartoffel. Zeitschr. Kartoffelbanges, **14**: 12–13, 1934.

Der nachweis von virus-infektionen an Kartoffelpflanzgut mit der stecklingsprobe, Der Züchter 7: 62–65, 1935.

Mischimfektionen mit verschiedenen stämmen der ringmosaikvirus (X–virus gruppe) der kartoffel. (Untersuchungen uber die viruskrankheiten der Kartoffel, IV.) Augew, Bot. **17**: 60–74, 1935.

Kramer, S[imon] P[endleton]
Bacterial filters. Science. **68**(1754): 88, 1928.

A brief discussion of bacterial filters which do not permit the virus of mosaic disease of tobacco to pass.

Kranzlin, G[ottfried]
Beitrag zur Kenntnis der Kräuselkrankheit der Baumwolle. (Contribution to the knowledge of the curl disease of cotton.) Der Pflanzer, Daressalam **6**(6–12): 129–145. 161–170, 1910.

Relation of cicadas to leaf curl of cotton.

Beiträge zur Kenntnis der Krauselkrankheit der Baumwolle. (Contribution to the knowledge of the curl disease of cotton.) Der Pflanzer, Daressalam **7**(4): 327–329, 1911.

Relation of cicadas to leaf curl of cotton.

Kunkel, L[ouis] O[tto]
Amoeboid bodies associated with *Hippeastrum* mosaic. Science **57**: 693, 1923.

Reports bodies in *Hippeastrum equestre.*

Plant pathology and man. W. B. Saunders Co. 207 p. 1926–27.

A lecture.

Heat treatment for the cure of yellow and rosette of peach. Phytopathology (Abstract) **25**(1): 24, 1935.

Possibilities in plant virus classification. Bot. Rev. **1**(1): 1–17, 1935.

Discusses the different methods proposed by other workers, the importance of biological carriers, evidence of relationships among the plant viruses and the new methods for differentiating plant viruses. Includes a bibliography of 88 titles.

Kuprewicz, V. F.

(Contribution to the physiology of diseased plants. Physiological data on the injury caused to cultivated plants by some fungus and virus diseases.) Thesis Acad. Sci. U. S. S. R. Bot. Inst. Leningrad 71 p., 1934.

The virus diseases included in this report are potato mosaic, leaf-roll and aucuba mosaic. Conclusions are based on experimental data.

Küster, Ernst

Beiträge zur Kenntnis der panaschierten Gehölze XXIII–XXVII. Mitt. Deutsch. Dendrol. Ges. **41**: 347–356, 1929.

Beiträge zur Kennthis der panaschierten Gehölze XXXI—XXXII Mitt. Deutsch. Dendrol. Ges. **43**: 343–348, 1931.

Beiträge zur Kenntnis der panaschierten Gehölze XXXVII—XXXI. Mitt. Deutsch. Dendrol. Ges. **45**: 286–293, 1933.

Beiträge zur Kenntnis der panaschierten Gehölze. XXXII—XXXIV. Mitt. Deutsch. Dendrol. Ges. **46**: 116–121, 1933.

Beiträge zur Morphologie der panaschierten Gewächse. Bioch. Zentralblatt. **54**(1½) : 89–95. 1934.

Kuwana, S. L.

Important diseases of rice crop in Japan. Proc. 4th Pacific Sci. Cong. Java **4**: 203–207, 1929.

Among other diseases reported by the author he mentioned a rice-virus disease called "ine no ishhiku byo" which occurs in the nursery beds and fields while the rice is young.

Lackey, C[harles] F[rankin]

Restoration properties of *Erodium cicutarum* on the attenuated curly-top virus. Phytopathology (title) **24**(10) : 1135, 1934.

Larter, L. N. H. & Russell, T. A.

Leaf stripe in maize. Dissertation for the A. I. C. T. A. 1930–31.

Unpublished.

Lehman, S[amuel] G[eorge]

Contaminated soil and cultural practices as related to occurrence and spread of tobacco mosaic. North Carolina Agric. Expt. Sta. Tech. Bull. **46,** 43 p., 1934.

Based on carefully planned tests the author gives yield and loss data. Also reports his observations in regard to soil transmission, its causes, and suggestions to prevent it. The spread of mosaic by laborers chewing or smoking while handling plants is also discussed.

Letoff, A. S.

(Some notes on diseases of newly cultivated bast yielding plants in Daghestan (1930). Diseases and pests of new cultivated textile plants.) Int. New Bast Raw Material, Moscow, p. 37–43, 1933.

In these notes report is made of a disease of *Hibiscus cannabinus* which has characteristics of a virus disease. The disease is described.

Likhité, V. N.

(The nature and relations of the intracellular inclusions present in the mosaic of tobacco.) Meded. Landb Wageningen **34** (1): 3–28, 1929.

Virus diseases of the tomato. Journ. Indian Bot. Soc. **9**(273): 114–125, 1930.

The author gives a brief history of the subjects and gives evidence that there is more than one virus.

------------., **& Dessi, G. H.**

Starch accumulation in stenosised plants. Current Sci. **3**(8): 356, 1934.

A brief note calling attention to the accumulation of starch in diseased plants.

Linford, M[aurice] B[lood]

Yellows (*Delphinium* sp.) Plant Dis. Reporter Supp. **65**: 42, 1927.

A record.

Linz, C. V.

Phony peach disease bearing. Flor. Exchange **78**(3): 33–34, 1934.

Report on quarantine bearing. A new test perfected. Origin of name explained.

List, G. M., & Daniels, L. B.

A promising control for psyllid yellows of potatoes. Science n.s. **79**(2039): 79, 1934.

This disease has not been proved to be due to a virus but is of interest to workers in virus diseases. The loss in Colorado in 1932 was 8 million bushels of potatoes. No evidence supporting bacterial or virus theories. Believed to be a toxin injected into the plant by *Paratrioza cockerelli.*

Livingston, L. G., & Duggar, B[enjamin] M[inge]

Experimental procedures in a study of the location and concentration within the host cell of the virus of tobacco mosaic. Biol. Bull. **67**(3): 504–512, 1934.

The results of the studies recorded in this paper are given in the summary as follows: "In this paper experimental evidence is offered which strengthens the view that the virus of typical tobacco mosaic occurs primarily, if not solely, in the protoplasmic components of the cell, rather than in the vacuole. From observations made it would seem clear that the occurrence of intracellular bodies, in hair at least, is coincident with or an accompaniment of relatively high virus concentration. The inclusion bodies, both vacuolate and striated types, are fragile structures disintegrating on contact with the micro-needle or pipette."

Loewenthal, H.

The cultivation of animal and plant viruses. Arch. für Exper. Zellforsch. **15**(2–4): 403–404, 1934.

A brief summary of the progress in virus cultivation since 1925 is given by the author. He expresses the opinion that progress in the cultivation of plant viruses, as opposed to animal viruses has been delayed by the difficulty of finding a medium analogous to that made from blood plasma and extracts, and suggests that the use of some lately discovered growth-promoting substances might give valuable results along this line.

Loree, R[obert] F[arls]

Virus diseases. In raspberry growing in Michigan. Michigan Expt. Sta. Circ. Bull. **152**: 34–36, 1934.

Brief popular discussion on the following virus diseases of raspberries; mosaic, curl and streak.

Ludwig, O.

Über Viruskrankheiten bei Pflanzen. (On virus diseases of plants.) Med. Klin. **1**: 52–55. 1933.

Ueber Viruskrankheiten bei Pflanzen. (On virus diseases of plants.) Med. Klin. **2**: 1–10, 1933.

Lushington, P. M.

Note on spike disease of sandal. Ind. For. **42**: 65, 1916.

In this note the author reports *Zizyphus aenoplia, Dodonaea viscosa, Pterolobium indicum, Argyreia cuneata, Solanum indicum, Cassia auriculata* and *Ficus tsiela* as presenting similar symptoms as those of spike disease of sandal.

Lutman, B[enjamin] F[ranklin]

Relation of structure of potato leaves to tip burn. Potato Mag. **5**: 1, 6; 22–23, 1922.

Tip burn is severe when degeneration diseases are present.

Mac Clement, D.

Purification of plant viruses. Nature **133**(3368): 760, 1934.

Description of a method adapted from one used by Warburg and Christian for the purification of a water-soluble ferment. It proved effective in the preparation of a purified suspension of any of the "X" group of plant viruses.

Malherbe, I. de V.

Little-leaf or rosette of fruit-trees. Farming South Africa. **9**: 312, 315, 1934.

Malhotra, R. C.

The effect of mosaic on the reserve materials in *Solanum tuberosum*. Biol. Gen. (Vienna) **9**(1): 257–262, 1933.

A brief review of the work of others.

Mandelson, L. F.

Citrus psorosis control. Department of Agric. and Stock. Queensland, Div. of Plant Path. Advisory Leaflet No. **8.** 4 p., 1933.

This paper gives a brief discussion of symptoms, varietal susceptibility, cause, conditions favouring the disease and control. The author states that it is probably due to a very slow growing organism. It is inserted here because there is some recent evidence in America that it is due to a virus.

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The importance of tobacco mosaic. Queensland Agric. Journ. **42**(5): 538–545, 1934.

Popular paper warning the growers of the importance of the dangers of tobacco mosaic. Gives symptoms, effects, nature, manner of spread and control of the disease.

Manil, P.

Note sur les nécroses foliaires du tabac dans les cultures de

vallés de la Semois en 1934. (A note on the leaf necroses of tobacco grown in the Semois valley in 1934.) Bull. Inst. Agron. & Stat. Rech. Gembloux **3**(4) : 367–377, 1934.

Report of a disease on tobacco of new occurrence in the Semois Valley, Belgium. The symptoms of the disease are described, no fungus or bacterium was found, although ordinary virus of ordinary tobacco mosaic was isolated in three occasions from the spots, it has not been determined if there is any association of the disease and any virus disease; nevertheless, from the evidence obtained the author concludes that this disorder is due to one or more specific viruses.

De la différenciación de certains virus phytopathogénes par l'action des complexes. (On the differentiation of certain phytopathogenic viruses by the action of complexes.) Compt. Rend. Soc. Biol. Paris **118**(4) : 376–379, 1935.

Report of experimental work on inoculations under controlled conditions.

Manns, T[homas] F[ranklin]

Our present knowledge on the dissemination of yellow and little peach. Trans. of Penn. Hort. Soc. Bull. of the State (Delaware Board of Agric. **23**(5), 1933.

The author reports that *Macropsis trimaculata* (the vector for peach yellows and little peach) lives primarily on the plum. He finds it in abundance *P. salicina* and other Japanese varieties and very sparing on the peach. Budding experiments show that plums are carriers of these diseases and that they show few or no symptoms. The death rate in peach orchards is greater when near plums than when not near them. "It is quite probable that the plums are the hosts which have brought the viruses of little peach and yellows into America.

------------, **& Manns, M. M.**

Plums as factors in the dissemination of yellows and little peach. Trans. Penn. Hort. Soc. **24**(6) : 72, 1934.

This is a continuation of the preceding paper. The Japanese plums (*Prunus salicina* and *P. simonii* and varieties) carry peach yellows and little peach, with more or less masking. The European (*P. domestica*) and American (*P. Americana*) are not as good carriers as the Japanese species. The Oriental specie (*P. myrobalon* and *P. musnoniana*) are capable of masking both yellows and little peach.

NOTE: Dr. Manns has been studying peach yellows and little peach for many years. Reports of progress are in the Annual Reports of the Delaware Agricultural Expt. Station.

------------ **& Adams, J[ames] F[owler]**

Department of Plant Pathology. Delaware Agric. Expt. Sta. Ann. Rpt. **1932–33** (Bull. **188**) : 36–46, 1934.

Studies on the masking of yellows and little peach in other species of *Prunus* indicated that some varieties of plums may act as carriers of these diseases, which can be disseminated from them by the leafhopper *Macropsis trimaculata* which lives principally in plums and very seldom is found on peach trees. Budding experiments are described.

Manzoni, L.

Attenti al roncet. (Attention to roncet). Battaglie Rurali **2**(3) : 2, 1933.

The author regards "roncet" or leaf roll of the vine to be caused by a filterable virus. In his opinion the disease was introduced into Italy with susceptible varieties from America. He gives some methods of control.

Marchal Emile [Jules Joseph]

Observations et recherches effectués á la Station de Phytopathologie de l' Etat pendant l'année 1933. (Observations and researches carried out at the State Phytopathological Station during the year 1933). Bull. Inst. Agron. and des Stat. de Res. de Gembloux. **III**(2) : 97–106, 1934.

This report contains interesting notes on sugar beet, mangolds, tobacco and dahlia mosaic.

Martin, W[illia]m H[ope]

Influence of degenerative diseases on yield. New Jersey Hints to Potato Growers **7**(6) Oct. 1926.

Popular.

Martinoff, S. I.

(Mosaic or Reisigkrankheit of the vine.) Agriculture, Sofia **38**(2) : 6, 1934.

As results of an official survey, the author found a vine disease, which was of some importance in 1930, spreading rapidly and causing considerable losses. He states that the disease shows much resemblance to vine mosaic in Czecho-slovakia. Reviewing the literature on the subject he notes what has been named as "mal nero", "reisigkrankheit", "roncet", "court-noué", "rougean", "brunissure", etc., are but different manifestations of the virus troubles, either due to varietal responses of the host or to ecological conditions. Description is given of the symptoms. No conclusion has been reached as to insect vectors, although the author suggests the possibility of two forms of *Phylloxera* (*P. vastatrix*, *P. gallicola* and *P. radicicola*). In the opinion of the author this disease is widely distributed all over the world and control measures are needed.

Martyn, E[ldred] B[ridgeman]

Mosaic disease of cane. Agric. Journ. British Guiana **2**(2): 112–113, 1929.

The author states that there is some doubt among a number of planters and others concerned with the sugar industry of the colony as to the appearance and nature of mosaic disease of sugar cane. Although the disease has been wide-spread over the world it is absent from British Guiana. The author gives a brief description of symptoms.

Botanical and Mycological Division. Annual Report **1929.** Agric. Journ. British Guiana **3**(4): 226–233, 1930.

(This annotation is to correct the one on **18**(1–2): 239 which is wrong.) ''The mosaic disease, though not yet known in British Guiana, occurs in Surinam, and I was enabled to see instances of it on an estate in the neighborhood of Nickerie. The cane principally affected was D–625, the variety so universally grown in this colony. At one time, I was informed, several fields had been badly infected and no steps having at first been taken to control the disease, up to 100 per cent infection had occurred upon 3rd and 4th ratoons. But by rouguing and replacing with the more resistant D–109, or in the worst areas by Uba, the disease has subsequently been kept under control, and has never spread from the section of the estate where it originally appeared.'' (Change made at the request of the author.)

Report of the botanical and mycological division for the year 1932. British Guiana Dept. Agric. Divisional Rpts. **1932**: 117–121, 1934.

Brief notes on sugar-cane mosaic and Liberian coffee-phloem necrosis.

Massee, A. M.

On the transmission of the strawberry virus ''yellow edge'' disease by the strawberry aphis together with notes on the strawberry tarsonemid mite. Journ. Pom. & Hort. Sci. **13** (1): 39–53, 1935.

This paper is a record of the study of the transmission of this disease by insects. The disease is transmitted by the strawberry aphis (*Capitophonis fragariae* Theo.) during June but not during the latter part of July and August. It is not transmitted by the strawberry tarsoneimid mite (*Tarcossemus fragariae* Zimm.).

Massey, R. E.

Section of Botany and Plant Pathology, G. A. R. G. Final Reports on experimental work in 1932–33. Gezira. Agric. Res.

Serv. Ann. Rpt. for the year ended 31st December 1933, p. 126–146, 1934.

In this report cotton-leaf curl disease is included and description of experimental work described as well as its insect vector *Bemisia gossypiperda*.

Matsumoto, Takashi, & Somazawa, Koetsu.

Immunological studies of mosaic diseases 1. Effect of formolization trypsinization and heat--inactivation on the antigenic properties of tobacco mosaic juice. (The Phytopathological Laboratory, Taihoku Imperial University, Contribution No. 8.) Journ. of Society of Tropical Agriculture **3**: 24–33, 1931.

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Immunological studies of mosaic diseases. IV. Effects of acetone, lead subacetate, barium hydroxide, aluminium hydroxide, trypsin and soils on the antigenic property of tobacco mosaic juice. Journ. of the Soc. of Trop. Agric. **6**: 671–682, 1934.

The author partially purified tobacco mosaic by the use of acetone, lead subacetate, barium hydroxide, aluminium hydroxide, etc., and found that mosaic juice remained antigenic as long as it was infectious. Confirmed Lojkins and Vinson's results that trypsin was able to inactivate the infectivity of virus when treated with acetone. The antigenic property and infectivity of the virus were impaired by passing through soils, especially sterilized and dry soils. The serological reaction may be due not to modified plant protein, etc., but to antigenic properties of the virus. It appears probable that the virus may be absorbed by the roots of plants in nutrient solutions.

Mc Carthy, C.

Progress Report of Forest Adminitration in Coorg for 1898–1899.

This report contains the first published record on spike disease of sandal that has come to the attention of the compilers.

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Unpublished memorandum on the future supply and culture of sandal in Coorg, 1899.

In this memorandum the external symptoms of spike disease of sandal are well described.

Mc Clean, A. P. D.

Streak disease of sugar cane. Proc. South African Sugar Tech. Asso. **7**: 73–79, 1933.

Mc Cubbin, W[alter] A[lex]

Peach yellows report 1929. Proc. State Hort. Assoc. Pennsylvania 7 : 113–118, 1930.

A survey.

Mc Kenny-Hughes, A. W.

Les pucerons comme vecteurs du *breaking* des tulipes. (Plant lice as vectors of "breaking" of tulips.) Deux. Cong. Int. Path. Comp. Paris. II Compt. Rend. et Comm. p. 447–449, 1931.

A brief review with special reference to insects.

Mc Kinney, H[arold] H[all]

Etude sur les mélanges de virus. (Study on virus mixtures). Deux. Cong. Int. Path. Comp. Paris 1931. II Comp. Rend. et Comm. p. 449–453, 1931.

A brief review.

Mc Rae, W[illiam]

Effect of mosaic on the tonnage and the juice of sugar cane in Pusa. Indian Journ. Agric. Sci. **1**(5) : 527–533, 1931.

Based on analysis and experiments the author illustrates with tables the results obtained in general. The loss in purity is more appreciable in Coimbatore seedlings than in tonnage.

————, & Subramaniam, L[ekshminarayapuram] S[ubrania]

Effect of mosaic on the tonnage and the juice of sugar cane in Pusa, Part III. Indian Journ. Agric. Sci. **3**(5) : 870–880, 1933.

In continuation of previous work it was found during the season 1932–33 from the experimental plots, that less juice was extracted from mosaic-infected than from healthy canes. There was slightly less glucose from diseased canes than from healthy ones, but the other differences were so small that they were not statistically significant.

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Effect of mosaic on the tonnage and the juice of sugar cane in Pusa, IV. Indian Journ. of Agri. Science. **4**(5) : 787–796. 1934.

This paper gives the results of field studies.

Mc Whorter, F[rank] P[aden] & Bouquet, A. G. B.

Suggestions for the control of tomato and tomato mosaic and streak. Oregon Agric. Expt. Sta. Circ. Inf. **84**, 4 p. 1933.

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English form of tomato spotted wilt found in Oregon greenhouse. U.S.D.A. Br. Plant Indus. Plant Disease Reporter **18**(5): 25–26, 48.

Based on observations made on the ornamental plants or native weeds in association with tomatoes affected by the English form of spotted wilt, it is concluded that the disorder must have been introduced on seed imported direct from England.

Megaw, W. J.
The improvement of stocks of potatoes by selection. Journ. Min. Agric. Northern Ireland **3**: 131–136, 1931.

A discussion of rate of degeneration, prevention of deterioration, propagation of selected stock and data on yields.

Mejía, R.
El mosaico de la caña en Antioquía. Bol. Agric. Soc. Antioquía Agric. Colombia, **8**(194): 3–9, 1934.

Merkenschlager, F[ritz]
Zur Diagnose und Pronose des Pflanzwerters der Kartoffeln. (On the diagnose and prognose of the value of the potato plants.) Der Kartoffelbau **16**: 109–111, 1932.

———————— **& Klinkowski, M.**
Ueber die Degeneration der Kartoffelabbau). (On the degeneration of the potatoes.) Wiener Landw. Ztg. **82**: 67–68, 1932.

Meyer, H[ans]
Das Chlorose—und Panachureproblem bei Chlorellen. II. Beih. Bot. Centralbl. **51**: 170–203, 1933.

Mikhailova, P. V.
(Anatomy of tomato plants affected with fruit woodiness. In virus diseases of plant in the Crimea and the Ukraine.) State Publ. Office for the Crimea, Simferospol p. 79–92, 1934.

The author states that tomato fruit woodiness present in the structure of the mesophyll and in the diseased leaves is characteristic of virus diseases.

———————— **& Pivovarova, R. M.**
(Consideration on the anatomical method of diagnosing virus diseases of the potato. In virus diseaes of plants in the Crimea and the Ukraine.) State Publ. Office for the Crimea. Simforopol, p. 93–108, 1934.

Based on the anatomical changes that virus diseases cause in the tuber of the potato plant, the authors discuss and give the results of their studies arranged in tabular form. The results given show that they are inclined to accept Quanjer's classification rather than the views given by von Brehmer and Rochlin.

M'Intosh, T. P.

Potato notes. Gard. Chron. **91**: 66–67, 1932.

Brief popular notes.

Moore, E[nid] S[tella]

The kromnek disease of tobacco and tomato in the eastern Cape Province. Farming So. Africa **8**: 378–380, 1933.

General popular account.

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Über die anatomische Diagnotikmethode der Kartoffelnvirus-krankheit. (On the Anatomical diagnostic method of potatoes virus disease.) In Rischkov, V., Viruskrankheiten der pflanz in der Krim und Ukraina. Forshung Inst. der Krim & Inst. f. Pflanzench. der Ukraine, Krimisdat p. 93–108, 1934.

Same as above.

------------, **& Wager, V. A.**

Kromnek: A serious tomato disease. Farming in South Africa, June, 1934.

Popular account warning the growers.

The leaf curl or crinkly dwarf disease of tobacco. Farming in South Africa, June, 1934.

Brief popular description of the disease giving control measures.

Morgenthaler, O.

Die Blattrollkrankheit der Kartoffel, eine Infektion oder eine Ernährungs-storung? (Leaf roll disease of the potato, an infection or a nutritional disturbance?). Mitt. Naturforsch. Gesellsch. Bern. 1933, p. 44–45, 1934.

Brief notes on the history of leaf-roll disease during the last thirty years.

Morris, O. M.

Apple rosette. Wahington Agric. Expt. Sta. Bull. **177**, 30 p., 1923.

The author states that apple rosette is a functional or nutritional disorder of apple and pear trees. After discussing its relation to

soil, fertilizer, pruning and other cultural practices concludes that growing a leguminous cover crop or shade crop in the affected orchard gave the best results in recovery from the disease. The author does not consider apple rosette as a virus disease.

Morstatt, H[ermann] A[lbert]

Die Degeneration bei unseren Kulturpflanzen, (Degeneration in our crop plants.) Blatt Pflanzenbau u. Pflanzenzucht **1**: 49–51, 1923.

Brief popular account on deterioration.

Viruskrankheiten der Pflanzen. (Virus diseases of plants.) Pflanzenbau **1**: 57–58, 1924.

Brief popular account.

Entartung, Altersschwache und Abbau bei Kulturpflanzen, insbesondere der Kartoffel. (Degeneration, senile decay and running out of cultivated plants, especially the potato.) Naturw. und Landw. Heft. **7**, 74 p., 1925.

The author discusses the concepts of degeneration, senile decay and running out, and develops his theory of an ecological basis for deterioration, especially of potatoes.

Der gegenwartige Stand unserer Kenntnis der Degeneration. (The present position of our knowledge on degeneration.) Angeu. Botanik **13**: 81–83, 1931.

Brief account of ecological theory of deterioration at this time.

Degeneration bei Kulturpflanzen und die Frage ihres Vorkommes bei Sisal. (Degeneration on cultivated plants and the question of its occurrence on Sisal). Tropenpflanzen **34**(3): 95–99, 1931.

Essentially the same as the above citation. There seems to be no deterioration in Sisal.

Morwood, R. B.

Potato diseases. Queensland Agric. Journ. **40**: 382, 395, 1933.

Potato diseases. Queensland Dept. Agric. & Stock. Phytopath. Leaflet **23**, 12 p., 1933.

Popular.

Mottet, S[eraphin Joseph]

La dégénérescence de la pomme de terre. (The potato degeneration.) Journ. Soc. Nat. Hort. France 4(23): 263–268, 1922.

Murata, T. J.

(Insect pests of the rice and barley and their control.) 364 p., 1915.

(Dwarf disease of rice plant.) Journ. Japanese Agric. Soc. **604**: 47–50, 1931.

Murphy, Paul A[loysius]

Potato inspection service. Agric. Gaz. **6**(3): 1–7, 1919.

Popular account about potato seed inspection, specially in regard to the so-called "running out" which in the opinion of the author is mainly caused by mosaic or leaf-roll diseases.

Discussion on "Ultra-Microscopic Viruses". Proc. Royal Soc. B **104**: 540–542, 1929.

The author expresses the opinion that plant virus diseases are more homogeneous than animal virus diseases. He divides the plant virus disease into two groups—those that are transmitted mechanically and those only by grafting or budding. He also states that he has found individual plants of the "up-to-date" variety of potato that were virus-free. He states that "perhaps the most important difference between plant and animal virus diseases consists in the very great regularity with which insects act as vectors of the virus diseases of plants".

Nattrass, R. M.

Annual Report of the Mycologist for the year 1933. Cyprus Dept. Agric. Ann. Rpt. **1933**: 48–57, 1934.

This report contains brief notes on potato and tomato virus diseases.

Neill, J. C., Brion, R. M.. & Chamberlain. E. E.

"Sore-shin": a virus disease of blue lupines. New Zealand Journ. **49**(3): 139–146, 1934.

The authors report the occurrence of a disease on blue lupine in New Zealand and call it "sore-shin". Description is given of the symptoms of the disease. From diseased material a *Fusarium* and bacteria were isolated but both failed to transmit the disease. Virus inoculation resulted in successful reproduction of the disease. No transmission occurred through the seed.

Nelson, Ray

Mosaic disease problems. Light thrown on this serious disease by a new discovery by Ray Nelson of Michigan Station. Michigan Quart. Bull. **5**(3):128–130, 1923.

Popular notes in relation to the author's paper which appeared in Tech. Bull. 58 of Michigan Agricultural Experiment Station.

Neuwiler, E.

Kartoffelanbannesluucke der Vereiningung Schwerzerijcher Verjuchs = Vermittlungegtellen fur Saatkartoffeln. (Potato cultivation experiments of the Association of Swiss Experiment Stations and Agencies for seed potatoes.) Landw. Jahrb. der Schweiz **45**: 513–538, 1931.

The results of field studies over a series of years.

Newton, William

Virus diseases of potatoes in British Colombia. Amer. Potato Journ. **8**(1):13–15, 1931.

Popular. Degeneration strains of potatoes were recognized by farmers before we knew much about virus diseases.

Nielson, Olaf

Kartoffelsorter og Kartoffelsygdomme. Fortsatte orienterende underspgelsen. (Potato varieties and potato diseases .) Saertryk of Tidsskrift for Planteavl, Kobenhavn. Bind. **40** (1):105–118, 1934.

This paper includes a very brief discussion of mosaic and leaf-roll diseases of potatoes.

Noble, R[obert] J[ackson]

Australia: Success in control of bunchy top disease of banana in New South Wales. Intern. Bull. Plant Prot. **7**:195, 1933.

Australia: summary of plant diseases recorded in New South Wales for the season 1932–1933. Internt. Bull. Plant Protect. **8**(1): 3–5, 1934.

The virus diseases reported were: Fig mosaic is widespread but generally unimportant. Pecan rosette was recorded for the first time. Mosaic occurred on *Zinnia elegans* and Iceland poppy (*Papaver nudicaule*).

Ocfemia, G[eraldo] O[ffimaria]

The transmission of the Fiji disease of sugar cane by an insect vector. University of the Philippines Nat. and Appl. Science Bull. **3**(3):277–280, 1933.

The author gives evidence that this disease is transmitted by *Perkinsiella vastatrix*. This is followed by a comparison of this disease with the bunchy-top of Abacá which is transmitted by *Pentalonia nigronervosa*.

Bunchy-top of Abacá: its nature and control. Philippine Agric. **23**(3) : 174–186, 1934.

Continuation of previous work cited above.

------------ & **Buhay, G. G.**

Bunchy-top of Abacá or Manila hemp: II. Further studies on the transmission of the disease and a trial planting of Abacá seedlings in a bunchy-top devastated field. Philippine Agric. **22**(8) : 567–581, 1934.

Due to the fact that bunchy-top of Abacá in the Philippine Islands has not been found spontaneously on bananas and that the authors were unable to transmit it by means of *Pentalonia nigronervosa* they concluded that the virus of banana bunchy-top in Australia is different from that on Abacá in the Philippines. Data are given on the transmission experiment and procedure for rehabilitation of devastated fields due to the disease.

Bunchy-top of Abacá. Univ. of the Phil. Coll. of Agric. Exp. Station. Circ. **27**, 13 p., 1934.

A popular paper giving symptoms of the disease, methods of spread and control.

Our work on plant diseases. Philippine Agric. **23**(5) : 467–475, 1934.

A popular account for the Silver Jubilee number in which the author gives brief notes on the work done on plant pathology in the Philippine College of Agriculture during the last 25 years. He gives special attention to the following diseases: Abacá bunchy-top, Fiji and mosaic diseases of sugar cane.

Ogilvie, L[awrence], Swarbrick, T., & Thompson, C. R.

A note on a strawberry disease resembling the American "crinkle". Agric. & Hort. Res. Sta. Univ. Bristol, Ann. Rpt. **1933**: 96–97, 1934.

Brief note reporting a disease very similar to that described by Zeller and Vaughan in United States known as crinkle and classed under the virus group diseases.

Oortwijn Botjes, J. G.

Die Gesunderhaltung der Saatkartoffeln. (The maintenance of healthy-potato seed.) Pflanzenbau (Berlin). Feb. 15, 1925.

The results of studies on field experiments in which the fields were planted on different dates.

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De invloed van abnormale minerale bemestingen op de aardappelplant. De vatbaarhoid voor viruszickten in verbani met abnormale Kalibemestingen. (The effect of abnormal mineral fertilizing on the potato plant. The susceptibility to virus diseases in connection with abnormal potassium fertilizing.) Landbouwk. Tijdschr. Maandbl. Nederl. Genootsch. Landbouwwetensch. **44**: 749–754, 1932.

Opitz, K., Tamm, E., Goepp, K., Rathsack, K., & Soltan, F.

Beiträge zur Kartoffelbau, insbesondere zum Abbauproblem. (Contribution to potato cultivation, specially in connection with the degeneration problem.) Landw. Jahrb. **79**(5) : 737–781, 1934.

This is a detailed report of five years, experiments conducted by the authors. It is very comprehensive and the results obtained well tabulated. Reference is made to the works of others in regard to degeneration diseases of the potato.

Orton, C[layton] R[oberts]

The virus diseases of plants. Bull. Amer. Delphinium Soc. **4**: 26–33, 1933.

Popular.

Orton, W[illiam] A[llen]

Phytopathology. Environmental influences in the pathology of *Solanum tuberosum*. Journ. Washington Acad. Sci. **3**(7): 180–190, 1913.

In this paper the only reference in relation to virus diseases is on page 189, which states: ''Both leafroll and curly dwarf develop suddenly from hitherto healthy stocks and both are transmitted by planting tubers from diseased plants. That whole districts should be affected as in Westphalia in 1907 and in Colorado in 1911 indicates a physiological deterioration due to environmental relations unless a parasite should be demonstrated, which has not yet been done.''

Osborn, H. T.

Incubation of the virus of pea mosaic in the aphid, *Macrosiphum gei*. Phytopathology (Abstract) **25**(1) : 31, 1935.

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Incubation period of pea mosaic in the aphid, *Macrosiphum pisi.* Phytopathology **25** (2) : 160–177, 1935.

Detailed discussion based on observations made in experimental work. It was difficult to transmit this mosaic by mechanical methods.

Palm, B[jorn] T[orwald]

The gametophytes in a composite affected with "Aster yellows". Svensk Bot. Tidskr. **27** (4) : 420–437, 1933.

In plants of *Troximon glaucum* spontaneously affected by aster yellows in Colorado, the author did not observe any abnormalities in the development of the anthers, tapetal, and sporogenous tissues, and male gametophytes. Other abnormalities or occurrence are described. He assumes the theoretical possibility that the pollen from an infected plant may convey the virus to the embryo sac of a healthy one in the process of fertilization.

Pape, H[einrich]

Die Mosaikkrankheit der Lilien. (The mosaic disease of lilies.) Gartenwelt **37** : 324–325, 364, 1933. (Zentrabl. Bakt. (Abstract) II **89** (17–20) : 431–432, 1934.)

Description of the disease which is transmitted by *Aphis gossypii.* Behavior of the disease is given and varietal susceptibility.

Patch, Edith M[arion].

Aroostook potato insects. Journ. Econ. Ent. **15** : 372–373, 1922.

List of 21 species in addition to aphids. Some may transmit degeneration diseases.

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Marooned in a potato field. Sci. Mo. **15** : 166–180, 1922.

Discussion of a species of aphid that transmits diseases and overwinters on rose bushes.

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Potato aphids. Maine Agric. Expt. Sta. Bull. **323**, 1925.

A discussion of aphids infecting potatoes and other solanaceous plants. This is of interest because some of these insects are vectors of virus diseases.

Park, Malcolm

Bunchy top disease of plantains. Ceylon Dept. Agric. Leaflet **18**, 2 p., 1934.

Popular.

Peacock, Walter M[iller]

Rouguing seed potato fields. Potato News Bull. **1**(10): 214-216, 1924.

Popular.

Peltier, George L[eo]

A mosaic disease of wheat. Boston meeting. Plant Path. Section (Abstract) Dec. 27–30, 1922.

Paper read. A record of the disease.

Perret, Claude

Maladies de la pomme de terre. Maladies de dégénérescence. Rapport sur le fonctionnement de l'Institut des Recherches Agronomiques pendant l'année 1931. (Diseases of the potato. Degeneration diseases. Report on the work of the Agricultural Research Institute for the year 1931.) Rep. Francaise, Min. Agric. Inst. Res. Agron. 42 bis, rue Bourgone. Paris VIIe p. 356, 1932.

Pethybridge, G[eorge] H[erbert]

Potato diseases. Journ. Min. Agric. **41**(2): 125–136, 1934.

The author makes reference to Bechhold's and Erbe's copper method for diagnosing leaf roll, which appears to be useless.

Petre, A. W.

Factors influencing the activity of tobacco mosaic virus preparations. Cont. Boyce Thompson Inst. **7**(1): 19–28, 1935.

The author reports improvements on the Vinson & Petre lead precipitation of mosaic virus from tobacco leaves. He believes that succulent plants are more susceptible than non-succulent plants of the same species.

Petri, L[ionello]

Court-noué de la vigne. Deux. Cong. Int. Path. Comp. Paris 1931. II. Compt. Rend. et Comm. p. 441–443, 1931.

A brief résumé.

Rassegna dei casi fitopathologici osservati nel 1933. (Review of phytopathological records noted in 1933). Boll. R. Staz. Pat. Veg. n. s. **14**(1): 1–78, 1934.

This report contains information on "court-noué" of the vine, regarded by some authors as caused by a virus and on bitter pit of apple.

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Sull'arricciamento (court-noué) della Vite. (On leaf roll (court-noué) of the vine). Boll. R. Staz. Pat. Veg. n. s. **14** (2) : 273–278, 1934.

In this paper the author expresses his opinion that this disease belongs to the virus group, which has been included in the third edition of Sourauer's Handbook of Plant Diseases. He discusses the assertion by Viala and Marsais who stated that the disease is due to the fungus *Pumilus medullae.*

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Degenerazione e necrosi del cambio dei Peri e dei Meli nel Trentino e in Alto Adige. (Degeneration and necrosis of the cambium of pear and apple trees in the Trentino and the Upper Adige.) Boll. Stat. at. Veg. Rome, n. s. **14**(3) : 281–326, 1934.

The author does not regard in this paper the disease as caused by a virus, but we include it due to its similarity of symptoms.

Piemeisel, R. L.

Weedy abandoned lands and the weed hosts of the beet leaf hopper. U.S.D.A. Circ. **229**, 23 p., 1932.

This is not a work on virus diseases of plants but is of interest to students on the subject, *Eutettix tenellus* Baker being the insect vector of beet curly top.

Pierce, W[alter] H[oward]

Resistance to common bean mosaic in the Great Northern field bean. Journ. Agric. Res. **49**(2) : 183–188, 1934.

Report of results obtained in field and greenhouse tests with certain strains of beans. The results showed that nine strains are immune to common bean mosaic and some tolerant to yellow bean mosaic.

Pittman, H. A.

Virus diseases of plants. With particular reference to the spotted or bronzy wilt disease of tomatoes. Journ. Dept. Agric. Western Australia ser. 2., **11**(1) : 123–140, 1934.

This paper deals almost entirely with spotted wilt of tomatoes. Gives the behavior of a considerable number of hosts to this disease. Gives detailed account of symptoms.

Plantegen, María H. J.

Páthologische verandenrigen in het phoem. (Pathological disturbance in the phloem.) Thesis Univ. Utrecht (Holland-brukkery, Baarn). 108 p., 1932.

In this rather extensive paper the author reports his experimental studies on the transmission and inoculations in regard to the phloem necrosis disease of coffee in Surinam.

Porter, D. R.

Infectious nature of potato calico. Hilgardia **6**(9) : 277–294, 1934.

This appears to be a virus disease. The author gives a history of the disease, symptoms, results of field and experimental studies, methods of transmission and effects on yield.

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Relation of virus diseases to potato production in California. California Agric. Expt. Sta. Bull. **587**, 32 p., 1935.

This bulletin gives a discussion of some of these diseases, including variations of symptoms, tuber indexing, rate of spread in the field, insects in relation to spread, varietal resistance and yield. The yield of table stock may be reduced 25 per cent.

Price, W[illiam] C[onway]

Isolation and study of some yellow strains of cucumber mosaic. Phytopathology **24**(7) : 743–761, 1934.

Descriptions of the behavior on different hosts of some yellow strains of cucumber mosaic and method of isolation.

Purdy Beale, Helen

Specificity of the precipitin reaction in tobacco mosaic disease. Journ. Expt. Med. **54** : 463–473, 1931.

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The serum reactions as an aid in the study of filterable virus of plants. Contrb. Boyce Thom. Inst. **6**(3) : 407–435, 1934.

The author reviews the literature on the subject and a precipitin reaction is recommended as a qualitative test in the detection of masked carriers in the identification of new hosts and in the classification of plant viruses. The reaction of several hosts is given to precipitin reaction with antiserum of tobacco virus I. A method for determining the antigenic content of saline extracts of tobacco virus I to which phenol has been added is described in detail. Description is given of Holmes' method of estimating local lesions. Results are given in using different numbers of plants (*Nicotiana glutinosa* L.) inoculated with known concentrations. A quantitative relation is shown to exist between the antigenic content and the active virus concentration of 11 separate extracts compared in eight different pairs. In seven out of eight of these pairs the concentration of virus probably does not vary more than 80 per cent and in the case of the remaining pairs, probably less than 50 per cent. The value of serologic technique is discussed.

Quanjer, H[endrick] M[arius]

De stand der onderzoekingen over de bladrolziekte, de mosaickziekte, de Krinke en de stippelstreepziekte. (The point reached by the investigations into the leafroll disease, the mosaic disease, the crinkle disease and the speckle streak disease.) Voordracten Eersten Aardappeldag Cent. Com. Inzake Kenring v. Gewassen, Wageningen p. 9–19, 1922.

(Influence of fertilization on the health of the potato.) Die Ernährung der Pflanze, **25**: 194–198, 1929.

A general paper with some attention to virus diseases.

De selectie van den aardappel en de invloed van nitwedige omstandigheden, speciaal van de bemesting, op het resultaat daarvan. Voordr. 4 Aardappeldag Centr. Com. Kenr. Gewass., Gehoud. Wageningen. (Selection of potatoes and the influence of external circumstances, especially of fertilizing on the results of this selection.) Lecture 4, Potato day Central Committee for testing—Wageningen.) July 1930, p. 542–552, 1930.

Results of studies on virus diseases in which fertilizers were tested for control. The insect *Myzus persicae* does not thrive in certain regions.

------------, **Thung, T. H., Elze, D[avid] L[eon], & Likhité, V.**

De virusziekten der planten. (Virus diseases of plants.) Landbouw. Tijdschr. der Ver. van Landbuw. **5**(10): 793–836, 1930.

A rather extensive and very comprehensive account of virus diseases of plants with the following chapters: 1. Introduction. Agricultural and scientific importance of the virus diseases. Definition of virus diseases. Bacteriophagy. 2. Genetical research. Deterioration of potatoes and sugar cane. Infection and variability of host plants and parasites. Asexual propagation of cultivated and wild plants, mosses and fungi. Breeding resistant varieties of sugar cane and potatoes. 3. Ecological methods. ''Running out'' or ''Abbau''. Importation of sugar-cane cutting from mountain regions. Importation of seed potatoes. Mycorrhiza-hypothesis. Climate and manure. 4. Grafting and budding as methods of investigations. Infectious chlorosis of ornamental plants. ''Peach yellows''. Comparison of viruses of potatoes, sandal tree and hop. Quercinatype of *Datura stramonium*. 5. Bacteriological, mycological and helminthological methods. Sereh disease of sugar cane. ''Curly top'' of sugar beet. Leafroll of potato. Tobacco mosaic. 6. Enzymatic methods. Investigations of the juice of mosaic tobacco and other plants. Comparison of different

mosaic diseases. Physiological investigations of leafroll and healthy potato plants. Spread of virus thru different manured plants. 7. Morphological and histological methods. Four types: 1. Chlorosis, (Phloemnecrosis, gummosis of vascular bundles, Pseudo-virus diseases); 2. Mosaic diseases; 3. Necrotical diseases. 4. Alloiophylly. 8. Methods of pure culture of virus diseases and of virus free plants. Sources of infection. Masking of symptoms. Varietal response to infection. ''Carriers''. Increase of virulence. Source of infection among related and non-related plants. Vira of tobacco and cucumber mosaic. Decrease of virulence. Specialization of mosaic vira. Polyphagy of mosaic vira. Separation of vira. 9. Advantages of tobacco mosaic in virus studies. Filtration and centrifugation. Fractional filtration. Quantitative determination. Chemical purification. Laboratory culture experiments. Corpuscular nature of vira. 10. Cytological methods. Iwanoski's results. Vacuolate bodies. Crystalloid material. Flagellate bodies. Elytrosomes and scolecosomes. Other cytological investigations. Vacuolate bodies as probable cause. 11. The importance of insects in the spread of viruses. Classification of the virus diseases according to their transmission by insects. Diseases which are spread by a specific insect. Diseases which are spread by different insects. Relation between insects, virus and plants. Spread by other animals than insects. Control. 12. Control of virus diseases. Empirical methods. Exclusion, protection, eradication, curing, immunization. Control of potato viruses. Other plants. 13. Bacteriophagy.

------------ La sélection des pommes de terre et l'influence des conditions extérieuses, des engrais en particulier. (Selection of potatoes and the influence of external conditions, in particular the fertilizer.) Bull. Soc. Intern. des Sélectionneurs de Plantes de Grande Culture **3**(2):1–9, 1930.

This paper has been cited on page 302 of the Bibliography. It appears also in Ernährung der Pflanze 27(1): 1–8, 1931.

------------ Die Auslese der Kartoffeln und der Einfluss der ausseren Umstande, insbesonderes der Dungung. Landw. Tijdschr., **42**, 542 p., 1930. (Zeitschr. Pflanzenkr. (Abstract) **42**: 491, 1932.)

------------ Pflanzenpathologie auf anatomisch-physiologischer Grundlage. (Plant pathology on the anatomical-physiological foundation.) Angew. Bot. Zeitschr. Erfs. Nutzpflanzen **6**(2): 225–237, 1934.

A general discussion on the subject but especially virus diseases of plants, reviewing the work so far.

Enpele kenmerken der "vegelings"—Ziekte van suiker— en volderbielen ter onderscheiding van de "Zwarte horlvaten" —Ziekte (Some symptoms of the "yellowing" disease of sugar and fodder-beet, and its differentiation from the "black wood-vessel" disease of these hosts.) Tijdschr. Plantens. **40**(10): 201–214, 1934.

This disease resembles a virus disease but there is no absolute proof that it belongs in that group.

Rademacher, B.
Erfahrungen über die wichtigsten Krankheiten der Ackerbohne und ihre Bekäfflpfung. (Experimental observations on the most important broad bean diseases and their control). Deutsch. Landw. Presse **41**(21): 253–254, (22): 275–276, (23): 290, 1934.

The author summarized briefly Boning's investigations on mosaic of *Vicia faba.*

Rangel, E[ugenio] S[antos]
O mosaic (Mosaic). A Lavoura, (Brazil) **31**(8): 589, 1927.

Rankin, W[illiam] H[oward]
Leaf curl mosaic or yellows of the cultivated red raspberry. Canada Dept. Agric. Interim Rpt. Dom. Botanist **1921–22**: 30–60, 1922.

Ravaz, L.
Sur la chlorose, Progr. Agr. & Vitc. **103**: 366–369, 1935.

Rawlins, T[homas] E[lsworth]
Cytology and other studies of curly-top disease of the sugar beet. Unpublished thesis in the Library of the University of California, 1926.

------------ **& Parker, K. G.**
Influence of rootstocks on the susceptibility of sweet cherry to the buckskin disease. Phytopathology **24**(9): 1029–1031, 1934.

Reports the author's observations of the effect of the so-called "buckskin" disease of the sweet cherry in grafting experiments.

------------, **& Tompkins, C[hristian] M[ilton]**
The use of carborundum as an abrasive in plant-virus inoculations. Phytopathology (Abstract) **24**(10): 1147, 1934.

Read, W. H.

Physiological investigations of mosaic disease of the tomato. Cheshunt Expt. and Res. Stat. Herkfordshire. 19th Ann. Rpt., **1933**: 64–67, 1934.

Account of analysis of samples of healthy and artificially inoculated with aucuba mosaic tomato plants, taken at intervals of two hours throughout a period of twenty-four hours.

Reddick, Donald

Some diseases of wild potatoes in Mexico. Phytopathology **22** (6): 609–612. 1932.

This paper includes a brief statement concerning virus diseases. No virus diseases were observed in the wild plants in Mexico. Wild mosaic developed on two wild and three cultivated plants when grown in Ithaca, New York. Leafroll was not seen in Mexico. However, the author reported a spot disease which was found later to be due to a virus.

Reed, H[oward] S[prague] & Dufrénoy, Jean

Éffects de l'affection dite "mottle leaf" sur la structure cellulaire des citrus. (Effect of the so called "mottle leaf" disease on the cytological structure of citrus trees.) Rev. Gen. Bot. **46**(541): 33–44, 1934.

As the title implies this is a study of the cytological structure of diseased citrus leaves, but we include it on account of its similarity to a virus disease.

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Modification in cell structure accompanying mottle leaf of the orange. Amer. Journ. of Botany **22**(3): 311–328, 1935.

This is not a virus disease but is of interest to students of virus diseases because of its resemblance to them.

Reinmuth, E[rnest] Friedrich & Finkembrink, W.

Experimentelles zur Frage der Eisenfleckigkeit der Kartoffel. (Experimental tests concerning the iron spot disease of the potato.) Ztschr. Pflanz. **43**: 21–28, 1933.

Riha, J., & Blattny, C[tibor Eugen Marie Karel]

Ergenbnisse des Versuches über das Verbreiten der Viruskrankheiten und der durch sie verursachten Degeneration der Kartoffeln in verschiedenen Gegenden der Tchechreslovakischen Republik in den Jahren 1926–29. Ochrana Rostlin **9**: 97–108, 1929.

Rischkov, V[itolij L.]

Einige neue wildwachsende buntblättrige Pflanzen. (Some new variegated wild plants.) Biol. Zentralbl. **47**(1): 18–25, 1927.

A discussion of chlorophyll in chlorotic leaves.

————————, **& Karatschevsky, I. K.**

Chlorophyllmangel und Eunzymwskung. I. Katalasewirkung bei Panaschierung und mosaikkrankheit. Biologie der Pflanzen. **20**: 199–220, 1933.

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Ueber die Entstehung von "Fern-Leaf" bei Tomaten. (On the origin of "fern-leaf" in tomatoes.) Phytopath. Zeitschr. **7** (3): 231–244, 1934.

Report of results obtained in inoculation experiments.

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(Experiments on the artificial transmission of virus diseases of the tomato. In Virus diseases of plants in the Crimea and Ukraine.) State Publ. Office for Crimea, Simferopol p. 7–30, 1934.

This paper contains a brief enumeration of virus diseases of tomato which have been hitherto described as *Stolbur* disease of tomatoes attributed to a virus and wide-spread in Crimea and also observed in Ukraine. Discussion on transmission and inoculation experiments.

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(Filterable virus as a cause of virescence of flowers. In Virus diseases of plants in the Crimea and the Ukraine.) State Publ. Office for the Crimea, Simferopol, p. 59–73, 1934.

This paper is a continuation of the preceeding one. It contains a detailed account of the teratological changes observed by the author in tomato flowers naturally or experimentally infected with "woodiness virus". The observations of the author agrees with those of Bald and Eardley. He believes that the Crimean disease is identical to that of Australia known as "big bud". They also agree with those described by Kostoff.

————————, **Karatschevsky, I. K.**

Die Viruskrankheiten der Tomaten und ihre experimentelle Übertragung. (Tomato virus diseases and its experimental transmission.) In his Viruskrankheiten der pflanzn in der Krim und Ukrania. Forshungs Inst. der Krim & Inst. f. Pflanzensch. der Ukraine, Krimisdat, p. 7–30, 1934.

Report of experimental transmission of tomato virus.

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Ultravirus als die Ursache der Vergrünungsercheinungen. In his, Virus Krankheiten der pflanzn in der Krim nud Ukraina. Forshungs Inst. der Krim & Inst. f. Pflanzensch. der Ukraine, Krimisdat, p. 59–73, 1934.

————————, & **Mikhailova, P. V.**
(On the nature of *Pseudocommunis* sp. In Virus diseases of plants in the Crimea and Ukraine.) State Publ. Office for the Crimea, Simferopol p. 114–121, 1934.

The authors report their cytological studies of potato tubers from plants affected with virus disease. As a result of their observations they found constantly intracellular bodies which appeared to be identical to Debray's *Pseudocommunis vitis*. They state that microchemical tests showed that these bodies are a product of cell metabolism under the influence of certain pathological processes.

————————, & ————————
Über die Natur d. *Pseudocommunis* sp. (On the nature of *Pseudocommunis* sp.) In his Viruskrankheiten der pflanz in der Krim und Ukraine. Forshungs Inst. der Krim & Inst. f. Pflanzensch. der Ukraina, Krimisdat, p. 114–121, 1934.

See preceding citation by the same authors.

Robbins, William J.
Isolation of the infective principle of virus diseases. Science **80**(2073) : 275–276, 1934.

The author reviews briefly the outstanding works of other investigators on the subject and based on assumptions establishes a table given the dilution and quantity of juice taken 100,000 the molecular weight of the infective material.

Roberts, J. I.
The tobacco capsid (*Egytatus* volucer, Kirk.) Rhodesia. Bull. Ent. Res. **21**: 169, 1930.

Refers to crinkle which is probably the same as ''Kroepoek''.

Rosa, J[oseph] T[ooker]
Relation of potato viroses to yield. Amer. Pot. Journ. **5**(7): 190–191, 1928.

Popular. Contains interesting data on yields.

Rosenfeld, A[rthur] H[inton]
Variedades de caña de azúcar inmunes o muy resistentes al

mosaico. (Sugar-cane varieties immune or very resistant to mosaic.) La Hacienda **25**: 489–490, 1930.

Popular.

Ross, A. F.

The effect of proteoclastic enzymes on purified preparations of tobacco mosaic virus. Phytopathology (Abstract) **25**(1): 33, 1935.

Ruhland, W., & Wetzel, K.

Zur Physiologie der sogenannte Blattrollkrankheit der Kartoffelpflanze. (On the physiology of the so-called leafroll disease of the potato plant.) Ber. Verhandl. Sachs. Akad. Wiss. Leipzig. Math.-Phys. Kl. **85**(3): 141–149, 1933.

It was found in leaves and tubers, dormant and sprouted potato, a higher content of dextrin and a lower content of sugar in leafrolled as compared to healthy ones. It was also found that in diseased material the diastatic activity was much lower, accompanied by a reduction of assimilatory capacity, transpiration and respiration.

Salaman, R[edcliffe] N[athan]

Discussion on "Ultra-Microcospic" Viruses. Proceedings of the Royal Soc. **B 104**: 550–552, 1929.

The author states that he has repeated the work of Johnson and Schultz in which the former inoculated tobacco with juice from apparently healthy potatoes and the latter inoculated potatoes with juice from apparently healthy potatoes. His results were negative. He called attention to the tolerance of host varieties, to attenuation of virus and varietal reaction in host plants.

------------ & Bawden, F. C.

An analysis of some necrotic virus diseases of the potato. Proc. Roy, Soc. ser. **B. 111**: 53–73, 1932.

Summary:

"A summary of the literature on streak is given, from which it appears that two distinct chemical states can be isolated.

"One of these is that described by Orton and commonly known as stipple-streak or leaf-drop streak and later designated, on the grounds of its histopathology, as acropetal necrosis. The other, known as top-necrosis, has been described by Quanjer on basis of its histopathology as acronecrosis.

"It has been shown that the former is the distinctive reaction in certain varieties of the Y virus of Kenneth Smith.

"Acronecrotic or top-necrosis has been shown to be divisible into at least four distinct groups based on its varietal reaction, and here designated as top-necrosis X, top-necrosis A, top-necrosis B, and top-necrosis C.

"The first three are alike in that when they do produce a top-necrosis in any given variety, it is unaccompanied by any mosaic symptom. Top-necrosis C, on the other hand, differs clinically by the fact that necrotic and mosaic symptoms occur together.

"It is shown that top-necrosis X is due to the action of the virus acting alone.

"Top-necrosis A is shown to be due to a complex containing X and Y, possibly associated with the virus X.

"Top-necrosis B is shown to be due to a complex containing both Z and Y.

"Top-necrosis C is likewise shown to be due to the presence of both viruses X and Y.

"Top-necrosis X and C complexes are capable of transmission by needle inoculation to other potato varieties, though it by no means follows that the resultant lesion is a top-necrosis. Top-necrosis B is uninoculable, and so is top-necrosis A, except that it can be conveyed to the varieties Arran Crest and Epicure by the needle.

"Carriers of top-necrosis A are found among many of our widest grown varieties ------."

------------ **& Hurst, C. C.**

Discussion on the microscopy of the filterable viruses. Journ. Roy. Micros. Soc. **52**: 237–238, 1932. (Univ. Cambridge School Agric. Mem. (Abstract) **5**: 30–31, 1933).

A brief discussion of the inclusion bodies in varieties of potatoes infected with different viruses.

Virus disease research in relation to the cultivation of the potato. Hort. Educ. Assoc. Year Book. D. (Wye. Kent) **2**: 45–50, 1933.

Popular.

The raising of blight-resistant varieties and virus-free stocks. 4 pp. (No place of publication or date on the copy in the hands of the compiler.) (1934).

Explains the efforts of the Potato Virus Research Station made to secure varieties free from virus diseases.

Sandford, G. B.

A malady of the potato in Alberta similar to psyllid yellows. Sci. Agric. **15**(1): 46–48, 1934.

Not a virus disease paper, but may be of interest due to similarity of symptoms.

Sarker, B. N., & Dutt, K. M.

Effect of mosaic disease on the tonnage and the juice of sugar cane in Patna. Indian Journ. Agric. Sci. **4**(5) : 797–802, 1934.

Summarized results of yields for 1933–34, following the same scope of Mc Rae and Sulvia-Maniam for previous years.

Sarrant, A.

(Sugar-cane Fiji disease.) Journ. Sta. Agron. Guadalupe **1** (4) : 116–119, 1921.

Brief discussion on the spread of Fiji disease of sugar cane and the legislative action taken in Guadalupe to prevent its introduction.

Savastano, Giulio

El mosaico del fagiolo in Italia. (Bean mosaic in Italy.) Boll. R. Staz. Patol. Veg. **12**(4) : 377–394, 1932.

Popular notes on the distribution, symptoms, description of the disease, varietal resistance to mosaic and control.

Schapiro, S. M.

Die Federblätter der *Lappa*. (The feather-leaf of *Lappa* sp.) In Rischkov, V. Viruskrankheit der pflanzn in der Krim und Ukraina. Forshungs Inst. der Krim & Inst. f. Pflanzensch der Ukraine, Krimisdat, p. 100–113, 1934.

Brief account of this disease attributed to a virus.

(Note: This article is cited under Schapiro, S. M. page 204.)

Schreven, D. A. van

Kalkgebrek als oorzaak van mergnecrose bij Aardappelpnollen (Lime deficiency as the cause of medullary necrosis of potato tubers.) Tijdschr. over Plantenziekten **40**(11) : 225–255, 1934.

Although this paper is not a discussion on virus diseases specially, it contains comparison on necrosis due to virus and other valuable data on the subject.

Schultz, E[ugene] S[chultz]

Potato diseases of virus group due to cause not yet known. U.S.D.A. Yearbook **1927** : 522–525, 1928.

Brief popular notes on potato virus diseases. Gives a list of the types of virus diseases, means of dissemination and experiments in control.

____________ & Folsom, Donald

Recent potato virus-disease information contributing to the production of better seed potatoes. 15 Annual meeting of the Potato Association of America pp. 203–227, 1928.

A popular review.

————————, **Bonde, Reiner, & Raleigh, W. P.**

Isolated tuber unit seed plots for the control of potato virus diseases and blackleg in northern Maine. Maine Agric. Expt. Sta. Bull. **370**, 32 p. 1934.

A thorough account of experiments on the control of virus diseases in potatoes.

Schweizer, J.

Verslag over het jaar 1925 door Dr. W. H. Arisz. Med. Bevekisch Proefstation **41**: 14, 1926.

Refers to "Kroepolk" and "Krepoli" which are probable same as "Kroepoek".

Serrano, Luis A.

Mosaico. (Mosaic). Imp. Bolívar, Caracas (Venezuela) 16 p., 1927.

Report of a trip of inspection made by the author to the northern sugar-cane region of Venezuela. It includes a brief review of the work of others and a short historical sketch. Gives symptoms and methods of control and prevention.

Servazzi, O.

Nota sulla classificazione isto-pathologica del Quanjer, deller virosi nolla potato. (Notes on the histo-pathological classification of Quanjer of the virus of the potato.) Defesa Pianta Torino **27**: 20–24, 1932.

Severin, Henry H[erman] P[aul] & Thomas, William W.

Notes on the beet leafhopper, *Eutettix tenella* Baker. Journ. Econ. Ent. **11**(3): 308–312, 1912.

This paper has no mention of virus diseases, but we considered it of interest to students on the subject due to the long list of host plants of the beet leafhopper which is a recognized insect vector of beet-curly top.

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Natural enemies of the sugar beet leafhopper in California. California State Comm. Hort. Mo. Bull. **4**(5–6): 277–280, 1915.

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Notes on the beet leafhopper *Eutettix tenella* Baker. Journ. Econ. Ent. **11**(3): 308–312, 1918.

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Notes on the behavior of the beet leafhopper (*Eutettix tenella* Baker) Journ. Econ. Ent. **12**(4): 303–308, 1919.

Detailed account of his studies. Although not a strictly virus disease paper it is of interest to students of the subject.

The beet leafhopper (*Eutettix tenella* Baker). California Agric. Expt. Sta. Ann. Rpt. **1918–19**: 70, 1919.

Brief notes on migration of this leafhopper and relation of species to beet-curly top disease.

Beet blight. California Agric. Expt. Sta. Ann. Rpt. **1919–20**: 62–63, 1920.

Brief note in relation to the progress of studies on beet-curly top.

The beet leafhopper, *Eutettix tenella* Baker. California Agric. Expt. Sta. Ann. Rpt. **1920–21**: 41–42, 1921.

Brief note reporting field experiments.

Summary of life history of beet leafhopper (*Eutettix tennella* Baker). Journ. Econ. Ent. **15**(5): 433–436, 1921.

Mosaic and curly leaf disease of sugar beets. Journ. Econ. Ent. **15**(3): 247, 1922.

Brief reviews of Robbins' paper (Phytopathology **11**: 349–365) and Boncquet's (Phytopathology 7(4): 269–289) on mosaic of sugar beets.

Infective beet leafhoppers (*Eutettix tenella* Baker), do not transmit curly leaf daily. Journ. Econ. Ent. **15**(4): 318–1922.

Brief note giving results of experiments.

------------, **Schwing, E[dward] A., & Hartung, W. J.**
Relation of leafhopper migrations to time of sugar beet plantings. Use of nicotine dust against the beet leafhopper, *Eutettix tenella* Baker. Curly leaf transmission experiments with leafhopper. California Agric. Expt. Sta. Ann. Rpt. **1921–22**: 83–85, 1922.

Brief notes reporting field experiments and observations.

Natural enemies of beet leafhopper (*Eutettix tenella* Baker). Journ. Econ. Ent. **17**(3): 369–377, 1924.

Although not a virus disease paper it is of interest to workers on the subject.

————————
Natural enemies of beet leafhopper (*Eutettix tenella* Baker); curly leaf transmission experiments; chemical substance or toxin; incubation period. California Agric. Expt. Sta. Ann. Rpt. **1923**: 125–128, 1924.

————————
Life-history of beet leafhopper (*Eutettix tenella* Baker) in California. Univ. California Pub. in Ent. **5**(4): 37–88, 1930.

Not a virus disease paper, but of interest to students of the subject.

————————, & **Freitag, Julius H.**
List of ornamental flowering plants experimentally infected with curly top. U. S. Dept. Agric. Plant Disease Rep. **17** (1): 2–5, 1933.

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Ornamental flowering plants naturally infected with curly-top and aster-yellows viruses. Hilgardia **8**(8): 233–260, 1934.

"Fourteen species of ornamental flowering plants in 13 genera belonging to 10 families have been found to be naturally infected with curly-top in California. Previously non-infective beet leafhoppers transferred the curly-top virus from the following 14 species of naturally infected plants to sugar beet: *Kochia scoparia* var. *trichophila, Celosia argentea* var. *cristata, Mirabilis jalapa, Dianthus plumarius, Pelargonium hortorum, Tropaelum majus, Viola tricolor* var. *hortensis, Viola cornuta, Petunia hybrida, Scabiosa atropurpurea, Zinnia elegans, Cosmos bipinnatus, Coreopsis tinctorea, Helichrysum bracteatum.* The curly-top virus was not recovered from *Dianthus caryophyllus, Mathiola incana, M. incana* var. *annua,* although showed reliable symptoms of the disease."

"Eight species and 3 varieties of ornamental flowering plants in 7 genera belonging to 4 families have been found to be naturally infected with aster yellows in California. Previously non-infective *Cicadula divisa* transferred the yellows virus from the following species and varieties of naturally infected plants to asters or celery; *Ranunculus asiaticus, Eschscholtzia californica, Godetia grandiflora, Chrysanthemum segetum, Zinnia elegans,* Double Giant Pink, Dahlia Flowered mixed, lilliput Scarlet Gem, *Tagetes patula,* I. *erecta* and *Helichrysum bracteatum.*"

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Weed host range and overwintering of curly-top virus. Hilgardia **8**(8): 261–280, 1934.

"The weeds growing on the uncultivated plains and foot hills and in the cultivated areas infected with curly top include 57 species in 28 genera belonging to 16 families. The wild plants growing on the uncultivated area demonstrated to be naturally infected with curly

top include 14 species in 13 genera belonging to 8 families. In the cultivated areas 26 species of weeds in 15 genera belonging to 9 families were found to be naturally infected with the disease. The curly top overwinters in 11 species of annuals and 3 species of perennial wild plants growing on the uncultivated area. Previously non-infective beet leafhoppers repeatedly recovered the virus from a perennial-ballscale (*Atriplex fruticulosa*) during a period of six months, when the tests were discontinued. Four species of perennials and 3 species of weeds sometimes annuals and sometimes perennial, growing in the cultivated area were demonstrated to be naturally infected with curly top.'' Several economic plants overwinter and were naturally infected with curly top. A list is given of ornamental flowering plants which were infected with curly top under natural conditions. The curly-top virus rarely overwinters in the male beet leafhopper since most of the males die during the winter.

Transmission of California aster and celery-yellows virus by three species of leafhoppers. Hligardia **8**(10): 339–361, 1934.

Detailed account of experimental studies in aster and celery yellows virus transmission by means of *Cicadula divisa, Thamnotettix montanus* and T. *germinatus.*

------------, **& Haasis, Frank A.**

Transmission of California aster yellows to potato by *Cicadulla divisa.* Hilgardia **8**(10): 329–335, 1934.

Report of experiments on transmission of aster yellows to potato by means of *Cicadula divisa* Uhl. (*Cicadula sexnotata* Fall.) Description of symptoms, incubation period and behavior of the virus is given.

Expriments with aster-yellows virus from several states. Hilgardia **8**(10): 305–325, 1934.

After a brief review of the work of other investigators of the subject the author gives the results of his studies based on experimental data.

Shapiro, S. M.

(A curious case of mosaic in *Lappa* sp. In virus diseases of plants in the Crimea and the Ukraine.) State Publ. Office for the Crimea, Simporopol p. 109–113, 1934.

A brief morphological account reporting a ''fern leaf'' disorder of a species of *Lappa.* It is the first record in weeds of such malformation of leaves. It is attributed to a virus.

Shapovalov, Michael

Some host response in graft transmissions of dieback streak of tomatoes. Phytopathology (Abstract) **24**(10): 1149, 1934.

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Chemical splitting of the tomato "Combination-Streak" virus complex. Phytopathology (Abstract) **25**(1): 33, 1935.

Sheffield, Frances M[arion] L[ena]
Intracellular inclusions in plant virus diseases. Deux Cong. Int. Path. Comp. Paris, 1931. II. Compt. Rend. et Comm. p. 481–482, 1931.

A brief note.

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Experiments bearing on the nature of intracellular inclusions in plant virus diseases. Ann. App. Biol. **21**(3): 430–453, 1934.

The author gives the results of a series of experiments and concludes that it is not possible to identify virus diseases by cytological characters alone but states that they are of value in supplementing other diagnostic features. She compares the behavior of these bodies produced by aucuba mosaic, Hy III and tobacco mosaic viruses. She also gives the results of treatments with chemicals and states that lactic acid induced the formation of amoeboid bodies like the X-bodies of tobacco mosaic but that they persisted for only a few hours.

Shull, J. M.
Comments on the "breaking" of tulips. Florida Growers **21**: 164, 1934.

Silberschmidt, Karl
Neuere Arbeiten über die Strömungsrichtung der Assimilate im Pflanzenstengel. (New works on the assimilation stream direction within the plant stem.) Die Naturwissenschaften Heft 43, **26**(10): 725–728, 1934.

A review of recent literature.

Simmonds, J[ohn] H[oward]
The spotted wilt of tomatoes. Queensland, Australia, Dept. Agric. & Stock, Phytopathological Leaflet **1**, 3 p., 1927.

A brief, popular discussion of symptoms, cause and control.

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Bunchy top of the banana and its control. Queensland, Australia, Dept. Agric. & Stock. Advisory Leaflet 12, 4 p., 1934.

A popular discussion of symptoms and control.

Slate Jr., Wm. L.

Comparative analysis of healthy and of diseased (calicoed) leaves of tobacco, tomato and petunias. Connecticut Agric. Expt. Sta. Bull. **258**: 372–373, 1924.

Brief note giving the analysis.

Smith, E. H.

Spotted wilt disease of tomatoes. Expt. & Res. Stat. Cheshunt, Circ. **7**, 1933. (Gard. Chron. **94**: 350, 1933.)

Smith, J[ohn] Henderson

Remarks on the size of plant viruses. Arch. für Exper. Zollforsch. **15**(2–4): 454–456, 1934.

The author discusses the "living entity" theory in regard to plant viruses. He is opposed to the term "living".

Smith, Kenneth M[anley]

Discussion of "Ultra-Microscopic Viruses". Proc. Royal Soc. **B 104**: 545–546, 1929.

The author raises the question as to whether the insect is an obligate alternate host for the virus or merely a mechanical carrier. He summarizes his discussion by saying: "By certain manipulation of the virus of potato mosaic, it is therefore possible to change its character and, by starting with the normal mild disease upon potato, to produce from it four apparently distinct diseases, or perhaps it would be more accurate to say, four distinct modifications of the virus, i. e., (1) ringspot of tobacco; (2) its highly infections counterpart in potato; (3) the virulent form of disease in tobacco; (4) the aphis produced green line disease, also in tobacco."

Nature complexe de certain virus causant des mosaïques de la pomme de terre. (The complex nature of certain virus causing mosaic of potato.) Compt. Rend. 2 Congr. Intern. Pathol. Comp. Paris, **2**: 443–445, 1931.

------------, **& Dufrénoy, Jean**

Botanique—Sur le virus Y des Solanées. (Botany—On virus Y of Solanaceae.) Proc. Roy. Soc. **B. 109**: 241–267, 1931. (Compt. Rend. Acad. Sci. (Abstract) **199**(21): 1147–1150, 1934.)

This annotation is taken from the abstract. The authors report their observations.

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Insects in relation to virus diseases of plants. Agricultural Progress **11**: 86–88, 1934.

This is a very brief and clear summary of our knowledge of this subject. It is a summary of a paper read at Cambridge, July, 1933.

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Some virus diseases of the potato and other farm crops. The Scottish Jour. Agric. **16**(4) 11, 1933.

After a brief discussion of the subject, the author gives a discussion of the mechanics of aphid attacks on plants. This is followed by a popular discussion of the virus diseases of the potato and of the potato viruses.

————————
Some aspects of the plant virus problem. Agricultural Progress **11**: 88–92, 1934.

A very brief but very clear review of the most important aspect of these problems. It is a summary of a paper read in London, December, 1933.

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The plant virus in the insect vector. Arch. für Exper. Zellforsch. **15**(2–4): 459, 1934.

The author states there are three kinds of relationship between plant viruses and the insect vectors: (1) purely mechanical, (2) semi or group specific and (3) specific. Other valuable data on the relations of the viruses and insect vectors are given.

The mosaic disease of sugar-beet and related plants. Journ. Minis. Agri. **41**(3): 269–274, 1934.

This is a popular paper giving a brief history of the disease, symptoms, weed hosts, method of spread and effects on the yield.

Report of experimental observations of the virus Y on Solanaceae, especially the tobacco plant.

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A virus disease of *Primula obconica* and related plants. Ann. Appl. Biol. **22**(2): 236–238, 1935.

A description of the disease and the results of inoculating the virus into other species of plants.

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A virus disease of cultivated crucifers. Ann. Appl. Biol. **22**(2): 239–242, 1935.

A description of the disease and the results of inoculations into other species of plants. The virus is usually fatal on *Nicotiana glutinosa.*

Smith, Loren B[arlett]

Notes on spinach breeding. Proc. for 1920. Amer. Soc. Hort. Sci. **17**: 146–155, 1921.

Report of experiments and methods in the production of a mosaic-resistant spinach at the Virginia Truck Experiment Station.

Smith, M. Smith

(The plant virus in the insect vector.) Archiv fur Exper. Zellforsch. Band **15**: 459, 1934.

A very brief review of the subject in which the author divided the insect vectors into three groups: (1) those in which the insect is a mechanical vector, (2) in which an insect species has a particular affinity for a plant virus which may be transmitted by other insect vectors, (3) in which a specific insect alone is able to transmit a definite virus.

Sommer, H.

Nochmals: Mosaikkrankheit an Kakteen. Gartenwelt **37**: 37–38, 1933.

Sorauer, Paul [Carl Moritz]

Handbuch der Pflanzenkrankheiten (Die nicht parasitaren Krankheiten). vol. I: 893–964, 1924.

Much of this is devoted to a review of virus diseases.

Soukhoff, K. S.

(Contribution to the physico-chemical characterization of the filterable viruses of mosaic. In Virus diseases of plants in the Crimea and Ukraina.) State Publ. Office for the Crimea, Simferopol, p. 31–38, 1934.

Report of experiments and observations made by the author in relation to the virus of tomato "fern-leaf" disease. The properties of the virus observed by the author do not agree with those reported by Mogendorff in which it was suggested that the virus under study belongs to the cucumber-mosaic group. The author believes that it belongs to the tobacco-mosaic group. Other valuable data is given.

Spencer, Ernest L.

Influence of nutrition on host susceptibility to yellow tobacco mosaic. Phytopathology (Abstract) **25**(1): 33, 1935.

Effect of nitrogen supply on host susceptibility to virus infection. Phytopathology **25**(2): 178–189, 1935.

A study was made of the effect of nitrogen supply on host susceptibility to virus infection. Turkish tobacco, *Nicotiana glutinosa* L. and Early Cluster beans were the hosts under study with different types of mosaic virus. The results of the study showed that

there is a definite correlation between host nutrition and host susceptibility to virus infection and that host susceptibility is not governed mainly by host vigor as judged by the rate of growth, but by some limiting factor the nature of which is at present unknown. Data are given as to rate of growth and host susceptibility in relation to nitrogen level.

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Influence of phosphorus and potassium supply on host susceptibility to yellow tobacco mosaic infection. Phytopath. **25** (5): 493–502, 1935.

The author says: "Data obtained in this investigation indicate that phosphorus supply has apparently only an indirect influence on susceptibility of tobacco to infection with yellow tobacco mosaic, inasmuch as susceptibility and growth seem to be correlated directly with each other. Potassium supply, on the other hand, has a direct influence in changing host susceptibility to infection. When more than 20 milligrams of potassium were added each day, susceptibility decreased appreciably. Growth, however, was not retarded noticeably until the addition of potassium exceeded 200 milligrams per day."

Sreenivasay, M.

Spike disease of sandal. Quinquennial survey investigations. Perfum. & Essent. Oil. Rec. **24**: 265–266, 1933.

————————, **& Rangaswami, S.**

Field studies on the spike-disease of sandal (*Santalum album* Linne) I. Observations on the natural dissemination of spike. Proc. Indian Acad. Sci. **1**(B): 143–154, 1934. (Mem. Indian Inst. Sci. No. 26, 1934.)

The fact that spike disease of sandal discontinued its natural spread and that it occurred in isolated outbreaks in areas far from all source of infection lead the authors to believe in virus-infected seeds and long-distance dispersal of the insect vectors effected by wind or other agencies. Data of observation on this subject is given in this paper.

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Contribution to the spike-disease of sandal. (*Santalum album* L.) LXVIII, Hydrogen-ion concentration and buffering capacity as factor of disease resistance. Journ. Indian Inst. Sci. **17A**: 153–164, 1934.

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Insect transmission of spike disease. Nature **133**(3358): 382, 1934.

The author makes the distinction of the stunting non-infectious condition of sandal due to environmental conditions and the highly infectious spike disease. Gives details of transmission experiment and positive results obtained in tests using *Moonia albimaculata*.

Ssuchov, K.

Material zur phsico-chemischen charakteristik des filtrierbaren Viruses. In Rsichkov, V. L. Viruskrankheiten der pflanzn in der Krim und Ukraine Forshungs Inst. der Krim & Inst. f. Pflanzensch. der Ukraine, Krimisdat, p. 31–38, 1934.

Investigations on the filtration of viruses and the different filters in use.

--------------, & **Lanschina, M. N.**

Pathologische Veräderungen in den pflanlichen Zellen der Kj. Wirkung und das Problem der X-Körper. In Rischkov, V. L. Viruskrankheiten der pflanz in der Krim und Ukraina. Forshungs Inst. der Krim & Inst. f. Pflanzensch der Ukraine, Krimisdat, p. 122–124, 1934.

Stahel, Gerold

De tegenwoordige stand van het onderzoek naar den overdrager der zeefvatenziekte van den Koffie. (The present status of the investigation on the vector of phloem necrosis of coffee). Landbouwproefstat. Suriname Meded. **7**, 9 p., 1934.

The author reports his observations in connection with his experiments on the insect vector of phloem necrosis of coffee. He observed that *Lincus* bugs may be concerned in the process of transmission.

Stanley, W. M.

The action of high frequency sound waves on tobacco mosaic virus. Science **80**(2076): 339–341, 1934.

The author reviews Takahashi and Christensen's work (Science 79: 415, 1934). Describes his experiment and concludes: "The results indicate that inactivation of virus by supertonic radiation is associated with cavitation of dissolved gas and with the presence of extraneous matter found in untreated juice, since high frequency sound waves of great intensity have practically no effect on purified virus under a high vacuum."

Chemical studies on the virus of tobacco mosaic. I. Some effects of trypsin. Phytopathology **24**(10): 1055–1085, 1934.

Discussion, based on experiments, on the decrease of infectivity of different viruses and the reaction on different hosts in relation to the interference of trypsin.

Chemical studies on the virus of tobacco mosaic. II. The pro-

teolytic action of pepsin. Phytopathology **24**(11): 1269–1289, 1934.

The author reports his studies and observations and concludes that since pepsin inactivates virus only under conditions favorable for proteolytic activity and since the rate of inactivation of virus varies directly with the concentration of active pepsin, it is concluded that the inactivation of virus is due to the proteolytic action of pepsin. This suggests the virus of tobacco mosaic is a protein, or very closely associated with a protein, which may be hydrolyzed with pepsin.

Chemical studies on the virus of tobacco mosaic III. Rates of inactivation at different hydrogen-ion concentrations. Phytopathology **25**(5): 475–492, 1935.

This paper is a record of experimental studies of tobacco-mosaic with reference to temperature hydrogen-ion concentration and virulence on *Nicotiana tobacum, Nicotiana glutinosa* and *Phaseolus vulgaris.* Experiments with tobacco ring spot and cucumber-mosaic viruses showed that they were less stable than tobacco-mosaic virus.

Stevens, Neil E.

An attempted analysis of the economic effects of cranberry diseases. U. S. Dept. of Agric. Plant Diseases Reporter **19**(8): 112–136, 1935.

Two pages are devoted to the false blossom. It is considered the most serious disease of this crop. It is the cause of heavy losses but may have prevented over production.

Stevenson, F. J., & Clark, C. F.

New potato varieties. Amer. Potato Journ. **11**(4): 85–92, 1934.

Report of new potato varieties resistant to disease, among them is the Katahdin potato variety which is resistant to mild mosaic.

Stewart, Fred Carlton

Observations on some degenerate strains of potatoes. New York (Geneva) Agr. Expt. Sta. Bull. **422**: 319–357, 1916.

"This is a detailed account of the behavior of a large number of potato plants of known parentage and belonging to degenerate strains of several different varieties. The object of the study was to increase our knowledge of the diseases or forms known as leaf-roll, curly-dwarf, mosaic and spindling-sprout or other forms of degeneration. The conclusion is reached that leaf-roll, curly-dwarf and mosaic are closely related disorders due to the same general, undetermined cause. In some respects they behave like bud varieties; but they present also important points of difference. All are transmitted

through the seed tuber. The progeny of affected plants almost invariable become affected. The heredity of spindling-sprout is still undetermined and its cause is largely a matter of conjecture. However, it may be stated that spindling-sprout is not correlated to leaf-roll, mosaic or curly-dwarf.''

Stone, R[oland] E[lisha]

Winter blight or streak of tomatoes. Paper read before the Canadian Phytopathological Society, December 1924 (unpublished).

Not seen by the compilers.

Storey, H[arold] H[aydon]

Streak disease of maize. Dept. Agric. Union of South Africa. Reprint from Farming in South Africa, September, 1926.

A short popular discussion of symptoms, spread by an insect and control.

Streak disease of maize. Union of South Africa. Dept. Agric. 8 p., 1926.

Popular.

Streak disease of Uba cane. Jamaica Dept. Agric. Microb. Circ. **6**: 38–39, 1926.

Brief popular notes on streak disease. According to the author the disease is not confined to Uba variety only, but has been found to affect 10 other varieties. The insect vector is the leafhopper *Balclutha mbila* Naud. *Aphis maidis* Fitch has always failed to transmit streak. Methods of control are given.

(Studies on the mechanism of the transmission of plant viruses by insects.) Arch. für Exper. Zellforsch. **15** (2–4): 457–458, 1934.

This is a condensed paper on the same subject by the author noted above.

The photodynamic action of methylene blue on the virus of a plant disease. Ann. Appl. Biol. **21** (4): 588–589, 1934.

Description of experiment by which the author concludes that the virus of a plant disease may be inactivated by exposure to light in the presence of a methylene blue and oxygen as has been done with animal viruses and bacteriophage.

Stout, Gilbert L[eonidas]

Peach yellows. Trans. Illinois State Hort. Soc. **63**: 479–493, 1929.

Popular.

Sukhoff, K. S., & Lanshina, M. N.

(Pathological changes in plant cells caused by the action of potassium iodide. (In connection with the problem of the nature of X bodies.) Preliminary communication. In virus disease of plants in the Crimea and the Ukraine.) State Publ. Office for the Crimea Simforopol p. 122–124, 1934.

The authors report in this paper the finding of X bodies in the cells of healthy beet plants treated with a 0.01 percent solution of potassium iodide. These inclusions resemble very closely those found by other workers in cells of beets affected with virus diseases.

Summers, Eaton M.

Types of mosaic on sugar cane in Louisiana. Phytopathology **24**(9): 1040–1042, 1934. (Sugar News **16**(2): 83–84, 1935.)

The author reports the finding of four distinct types of mosaic which were very different in virulence. One of them was much more virulent than the others and very destructive.

————————, **& Rands, R. D.**

Losses due to planting of mosaic seed cane. The Sugar Bulletin **13**(15): 2–6, 1935.

This is a very important paper for Louisiana growers of sugar cane. It gives the results of studies on germination and yields of Co 281, Co 290, POJ 234 and C P 29/291. It urges the growers to select mosaic-free cane for planting and gives instructions for doing so.

Sundararaman, S.

The mosaic disease of sugar cane. Madras, Dept. Agric. Leaflet **42**, 2 p., 1926.

Brief popular notes on sugar-cane mosaic.

Takahashi, William N., & Rawlins, T[homas] E[lsworth]

Application of stream double refraction in the identification of streak disease of tomato. Phytopathology **24**(10): 1111–1115, 1934.

The author summarizes: "Juice from streaked tomato plants infected with a combination of tobacco-mosaic and potato latent viruses exhibits a stream double refraction indistinguishable from that exhibited by tomato plants infected with tobacco-mosaic virus alone." "Juice from tomato plants infected with dieback streak exhibits a stream double-refraction behavior which is indistinguishable from

that shown by normal plants. This technic may therefore be used to distinguish diseased plants infected with combination streak from those infected with dieback streak.''

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The relation of stream double refraction to tobacco mosaic virus. Science **81**(2099): 299–300, 1935.

This is a continuation of previous studies by the authors. They advance three theories for this phenomenon and summarize the results as follows: ''Although much of the evidence cited above favors the supposition that the virus particles are the causal agent of most of the stream double refraction exhibited by juice from mosaic plants the evidence remains inconclusive.''

Takata, K[azno]

(Results of experiments with dwarf diseases of rice plant.) Journ. Jap. Agric. Soc. (171): 1–4, 1895, (172): 13–32, 1896.

Thiele, R.

Ein Fall typischer Kräuselkrankheit bei Baumwolle im Gewächshaus. (A case of typical leaf-curl on cotton in the glasshouse.) Zeitschr. Pflanzenkrankh. **23**: 198–201, 1913.

Thompson, A.

Diseases of tobacco in Malaya. Malayan Agric. Journ. **22**(6): 263–269, 1934.

The author describes briefly the symptoms, manner of spread and control of tobacco mosaic.

Thornberry, H. H.

Particle size of three strains of tobacco mosaic virus. Phytopathology (Abstract) **25**(1): 36, 1935.

Thung, T. H.

Epidemiologie de quelques maladies de tabac. (Epidemiology of some diseases of tobacco.) Deux. Cong. Intern. Path. Comp. Paris, 1931. II Compt. Rend. et Comm. p. 482–484, 1931.

A very brief discussion of mosaic and Kroepoek.

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Jaarverslag 1 Mei 1930—30 April 1931. Proefst. Vorst. Tabak Meded. **71**: 21, 1931.

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De epidemiologie van tabaksziekten. Proefs. Vorst. Tabak. Aug. 1931.

The author gives results of experimental work with mosaic and kroepoek.

Phytopathologische waaremingen. Proefes. Vorst. Tabak. Meded. **76**: 20–25, 1932.

This paper gives the results of experimental studies on mosaic and "kroepoek".

Over enkele tabaksvirusziekten, de dovr insecten worden verbreid. Overgedrukt uit Nerslag 13 e. Bijeenkomst van de Vereeniging van Proefstation-Personeel, 1933.

Phytopathologische waarnemingen. (Phytopathological observations.) Proefstat. Vorst Tabak, Meded. **77**: 34–48, 1934.

Notes on a new form of tobacco mosaic characterized by wispy leaves. Proof also has been obtained, that ordinary mosaic of tobacco is disseminated in the fields by laborers.

Bestrijding der krul—on kroepoekziekten van tabak. (The control of curl and crinkle-diseases of tobacco.) Proefs. Vorst. Tabak. Meded. **78**: 3–18, 1934.

This paper is a continuation of the studies reported in No. 72. The disease is carried by *Bemisia* sp. and attacks the following weed hosts: *Ageratum conyzoides, Synedrella nodiflora* and *Vernonia cinerea.*

Tice, C[ecil]
Seed-potato certification in British Columbia. Potato Magazine **4**(10): 6, 1922.

Rules.

Tims, E[ugene] C[hapel]
Severe type of mosaic on sugar-cane variety. Phytopathology (Abstract) **25**(1): 36, 1935.

Tolas, A. G.
Minnesota certification rules. Potato Mag. **4**(9): 10, 18, 1922.

Rules—Legislation.

Tompkins, C[hritian] M[ilton] & Gardner, Max W[illiam]
Spotted wilt of head lettuce. Phytopathology (Abstract) **24** (10): 1135–1136, 1934.

A destructive virus disease of cauliflower and other crucifers. Phytopathology (Abstract) **24**(10): 1136–1137, 1934.

Breaking in stock (*Manthiola incana*), a virosis. Phytopathology (Abstract) **24**(10): 1137, 1934.

Torres Filho, A[rthur]

O combate do mosaico da canna de assucar. (The control of sugar cane mosaic.) Brasil Agricol. **12**(2): 65, 1927.

Recommendation of the planting of resistant varieties.

Tropova, A. T.

A contribution to the diseases of American jute. (Diseases and pests of new cultivated textile plants.) Inst. New Bast Raw Material. Moscow p. 58–60, 1933.

Brief note reporting that *Abutilon avicennae* growing near tobacco plantations showed a disease very similar to reticulate mosaic of tobacco. Investigations are still in progress in the study of this malady.

Trotter, Alessandro

La degenerazione della patata e le malattie da virus. (Potato degeneration and virus diseases.) Richerche, osservazioni ed divulgazioni Fitopatologiche per la Campania ed il Mezzagiorno (Portici). R. Lab. Pat. Veg. Portici **3**: 18–48, 1934.

Review of our knowledge so far on virus diseases of the potato. Discusses the different types of the diseases (mosaic, leafroll, witches' broom, pseudo-net necrosis and concentric necrosis). Quanjer's classification, Schander and Bielert necrotic tissue changes and Elze transmission by insects. Control measures are also considered.

Trümpener, Egon

Wie erkennt man den Abbau der Kartoffel? Der Kartoffelbau **17**: 61–62, 1933.

Die Blattrollkrankheit. (The leafroll disease.) Kartoffel **13**: 210–213, 1933.

Tu, C.

Notes on diseases of economic plants in South China. Lignan Sci. Journ. **11**(4): 489–504. 1932.

This report contains several brief notes on virus diseases of economic plants.

Unite, Juan O., & Capinpin, J[osé] M[ananjaya]

Selection of mosaic free cuttings of sugar. Philippine Agric. **15**(2): 67–73, 1926. (Planter & Sugar Manuf. **77**(8): 147–148, 1926.)

A brief paper in which the authors report (1) that first generation plants from mosaic resistant plants in severely infected fields do not show symptoms of disease; (2) that mosaic-free points produce diseased plants; and (3) that buds from infected stalks invariably give diseased plants, although the leaves of these buds do not show symptoms.

Uppal, B[adri] N[ath]

The absorption and elution of cucumber mosaic virus. Indian Journ. Agric. Sci. **4**(4) : 656–662, 1934.

Detailed account, illustrated with tables, of an experiment on the filterability of the cucumber-mosaic virus.

The movement of tobacco mosaic virus in leaves of *Nicotiana sylvestris.* Indian Journ. Agric. Sci. **4**(5) : 865–873, 1934.

The author gives the results of his experimental observations.

The effect of dilution on the thermal death rate of tobacco-mosaic virus. Indian Journal Agric. Sci. **4**(5) : 874–879, 1934.

The effect of dilution on the thermal death rate of the ordinary tobacco-mosaic virus was determined by the local lesion method on *Nicotiana glutinosa,* and a hybrid between it and *N. tobaccum.* He gives the range of temperature and the correlation of dilution. The thermal death point was established close to 70° at a dilution of 1 in 10,000.

Valleau, W[illiam] D[ornay]

Ring spot (Delphinium sp.) Plant Dis. Rept. **65**: 419, 1927.

A record.

A virus disease of Delphinium reported from Kentucky, Plant Disease Reporter **14**: 118. 1930.

A record.

Do tobacco plants recover and develop an immunity from ring spot? Phytopathology (Abstract) **25**(1) : 37, 1935.

The resistance of Ambalema tobacco to different viruses. Phytopathology **25**(1) : 37, 1935.

Varadaraja Iyengar, A. V.

Contribution to the study of spike-disease of sandal (*Santalum album* Linn.) Part XVI—Distribution of arsenic in sandalwood treated with sodium arsenite. Journ. Indian Inst. Science. **17A**(12): p. 131–139, 1934.

Large quantities found in bark and sap wood; the movement was noticed in the roots; the greatest concentration in the girdled regions; root suckers often killed; the oil from sprayed trees did not contain the poison.

Venkata Rao, M. G.

A preliminary note on the leaf curl mosaic disease of Sandal. Mysore Sandal Spike Invest. Comm. Bull. **3**, 5 p., 1934.

Preliminary note appearing in Indian Forester 49(12): 772–777, 1933.

———————— **& Gopalaiyengar, K.**

Studies in spike disease of Sandal. (1) Two types of spike disease, (2) The movement of the virus in Sandal plants. Indian For. **40**(7): 481–491, 1934. (Mysore Sandal Spike Invest. Comm. Bull. **4**, 1934.)

The authors describe the two types of sandal spike observed in India. By means of grafting experiments the movement of the virus within the plants was observed.

———————— & ————————

Studies in spike disease of sandal. Methods of inoculation and variation of results under different methods. Mysore Sandal Spike Invest. Comm. Bull. **5**, 13 p., 1934.

Different methods of inoculation by which spike disease of sandal can be transmitted are described. The fundamental principle in all methods is the grafting of infected tissue on healthy stocks. Results are given.

————————, **& Iyengar, K. G.**

Studies in spike disease of Sandal. Methods of inoculation and variation of results under different methods. Indian Forester **40**(10): 689–701, 1934.

Detailed account giving results obtained by the author with the methods successfully used in the transmission of sandal-spike disease.

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The role of under-growth in the spread of the spike disease of sandal. Indian For. **41**: 169–188, 1935.

Verhoeven W[ilhelm] B[oudewijn] L[eenweburg]

Invloed van Zeenwsche Blauwen op Eerstelingen. (The influence of zeenwsche Blauwen on Eeerstelingen.) Tijdschr. over Plantenziekten **40**(8) : 173–174, 1934.

Report of the behavior and influence of potato varieties which harbours the streak virus in a marked form.

Verplancke, G[ermain]

La Culture de la Pomme de terre dans l'Etat de Maine (Etats-Unis d' Amérique.) (Potato culture in the State of Maine, United States of America.) 16 p., 1919.

On pages 9 to 14 the author discusses potato virus diseases.

De la valeur de la "Tuber testing method" dans la sélection sanitaire de la Pomme de terre. (The value of the tuber testing method in the sanitary selection of the potato.) Stat. Phytopath. de l'Etat. Gembloux (Belgium) 7 p., 1927.

Report of experiments on tuber testing for mosaic and leaf-roll disease.

Etude sur l'organisation de l'inspection sanitaire de la culture de la pomme de terre en Belgique.—Studie over de inrichting van den gezondheidskeuring van de aardappelkweek in België. (Study of the organization of the sanitary inspection of the potato culture in Belgium.) Belgium Min. Agric. 27 p, 1929.

Regulations for seed certification in which virus diseases receive considerable attention.

Experiences sur la transmission des maladies de dégénérescence de la Pomme de terre. II. Résultats des essais faits en 1931: (Experiments on the transmission of degeneration diseases of potato. II. Result of tests made in 1931.) Ann. Gembloux **37** : 345–349, 1931.

A continuation of studies in papers with the same title.

Étude comparative de Pomme de terre d' origines diverses. I. Resultats des expériences faites en 1931. (Comparative studies on potatoes from different origins. I. Results of experimnts made in 1931.) Bull. Inst. Agron. Sta. Res. Gembloux, **1** : 123–145, 1932.

Records and discussion of field results in tabular form.

Les viroses de la Betterave. (The viruses of beet root.) La Sucrerie Belge **53**(1): 2–10, (2): 22–32, 1933. (Publ. Inst. Belge Amélioration Betterave, Tirlemont, **6**: 232–248, 1933.)

The author states that mosaic and yellows are the two virus diseases affecting beet in Belgium. He is working on four types of mosaic; speckled, veined, marbled and pocked mosaics. He gives an account on the cytology, transmissibility, wild hosts, varietal resistance and insect vectors.

Étude comparative de pomme de terre d'origines diverses. III. Resultats des expériences faites in 1933. (A comparative study of potatoes of various origins. III. Results of experiments made in 1933.) Bull. Inst. Agron. Stat. Res. Gembloux, **3**(1): 52–91, 1934.

Continuation of previous work.

Sur une forme nouvelle de la "bigarrure" maladie á virus filtrant de la pomme de terre. (On a new form of the "bigarrure" disease of the filterable virus of the potato.) Soc. Roy. Bot. Belg. **66**(2): 107–121, 1934.

Description of type of acropetal necrosis of potato plant.

Contibution á l'étude des maladies á virus filtrants de la Betterave. (Contribution to the study of filterable virus diseases of beet root.) Mem. Acad. Roy. Belgique, Cl. Sci. Ser. II, **1451** (III, 1), 104 p., 1934.

This article is an expansion of the author's paper entitled "La virose de la Betterave" cited above.

Etude des propriétés des virus causant les maladies de dégénérescence de la betterave. (Study of the properties of viruses causing degeneration diseases of the beet.) Sucrerie Belge **54**: 142–251, 1934.

General discussion of the properties of the viruses causing degeneration diseases of the beet, specially yellowing and mosaic.

------------, **& Asaert, L.**

Immunologische reakties met plantenvirus (Immunological reactions with plant viruses.) Natuur, Tijdschr. **16**(2–5): 69–74, 1934.

The authors give brief notes of their results obtained with different viruses and different hosts.

Etat actual de la production de la pomme de terre in Belgique. (Actual state of potato production in Belgium.) Reprint from Ann. de Gembloux p. 185–196, May, 1934.

In this paper is given the effect of virus diseases on the production of potatoes in Belgium.

Verwoerd, Len

Storage pit (bitterpit) of apples. Farming So. Africa **8**: 418, 430, 1933.

Vielwerth, V.

Mosaika Americké Revy vinné. (Mosaic of the American vine.) Ochrana Rostlin **13** (3–4): 83–90, 1933.

Account of a disorder on American varieties of vines occurring in Czechoslovakia which is transmitted by grafting and with characteristics of a virus disease. Studies of the disease are in progress.

Vizioli, J[osé]

O mosaic e outras molestias da canna de assucar. (Mosaic and other diseases of sugar cane). Sec. Agric. S. Paulo (Brasil) 1926.

Vos, H[uguette] C[onstance] C[ornelia] A[driana] A[bdia]

De invloed van *Pseudococcus citri* (Risso). Fern. op de plant. Baarn—N. V. Hollandia-Drukkerij pp. 1–81. 1930.

This paper is not a discussion of a virus disease but is of interest to those who are studying the mechanics of plants with viruses spread by means of insect vectors.

Wallace, H. F., & Anders, C. B.

Report Raymond Branch Experiment Station. Mississippi Agric. Expt. Sta. Bull. **231**, 1925.

On pages 14–17 data are given as to the results of seed certification in relation to potato-mosaic disease.

Report of the Mycologist, 1933. Tanganyika Territory Dept. Agric. Ann. Rpt. **1933**: 76–78, 1934.

Notes on virus diseases of cowpeas, other legumes, tobacco and sesame are included in this report.

Weger, F. W.

Die Blattrollkrankheit der Kartoffel. (The leaf roll disease of potato.) Ztschr. f. Pflanzenkrank. 29, 1919.

Bekämpfung der Blattrollkrankheit der Kartoffel. (The fight of leaf roll diseases of potato.) Landw. Brennerei Ztg. Prag. 1920.

Went, F. A. F. C.
Does the Sereh disease exist in the West Indies, more especially in Trinidad? West Indian Bulletin **12**(4): 554–560, 1912.

He found suspicious cases but no positive evidence of the disease.

Weimer, J[ames] L[e Roy]
Effect of environmental and cultural factors on the dwarf disease of alfalfa. Journ. Agric. Res. **47**(6): 351–368, 1933.

Continuation of previous work. This is the result of experiments started in 1929. Dwarf disease of alfalfa is not regarded by the author as a virus disease.

Wellman, F. L.
Identification of celery virus 1, the cause of southern celery mosaic. Phytopathology **24**(7): 695–725, 1934.

Description of a new virus which causes a true mosaic on celery. It is transmitted by *Aphis gossypii* and artificial juice inoculation.

A disease of banana markedly similar to bunchy top, produced by celery virus 1 in U. S. A. Phytopathology **24**(9): 1032–1034, 1934.

Report of the susceptibility of *Musa sapientum* variety Lady Finger to celery virus I. Gives behavior of the disease in inoculated plants, aphis transmission and description of the disease.

Infection of *Zea Mays* and various other Gramineae by the celery virus in Florida. Phytopathology **24**(9): 1035–1037, 1934.

The author found that celery virus I, the cause of southern celery-mosaic, has a very wide host range. He gives the host plants affected by this virus. He made inoculations by means of *Aphis gossypii.*

Dissemination of southern celery-mosaic virus on vegetable crops in Florida. Phytopathology **25**(3): 289–308, 1935.

This virus is carried by *Aphis gossypii* and attacks celery, corn, squash, pepper and several weeds. The author traces its dissemination by *A. gossypii* from weeds throughout the celery fields and illustrates his studies with maps.

The host range of the southern celery-mosaic virus. Phytopathology **25**(4): 377–404, 1935.

The paper is the result of experimental studies with celery virus I. The author was able to produce the disease by inoculation in 91 species of plants including 29 vegetable crops.

Werner, H[arvey] O[scar]

Spindle tuber, the cause of "run-out" potatoes. Amer. Potato Journ. 3(1): 16–18, 1926.

Popular—Some of the work in this paper will be found in Nebraska Sta. Bull. 207.

The tuber-index method in relation to seed potato certification. Proc. 15th Ann. Meeting Potato Assoc. Amer. p. 140–150, 1928.

Brief review of other workers, tuber-index system of eliminating virus diseases. He reports in this paper the results he obtained.

Effect of cultural methods and maturity upon the seed value of Eastern Nebraska potatoes. Nebraska Agric. Expt. Sta. Res. Bull. **45**, 45 p., 1929.

This paper contains valuable information in regard to spindle tuber of potatoes.

Some facts concerning the productivity of irrigated seed potatoes. Proc. 16th Ann. Meeting Potato Assoc. Amer. p. 120–132, 1929.

The author gives the results of his observations in regard to the relation of irrigated and not-irrigated potatoes to spindle-tubers.

Werwoerd, L.

Storage pit (bitter pit) of apples. Farming South Africa **8**: 418–430, 1933.

Whetzel, H[erbert] H[ince]

Diseases of the peony. Amer. Florist **44**: 609–612, 1915.

White, Philip, R.

Multiplication of the viruses of tobacco and aucuba mosaics in growing excised tomato root tips. Phytopathology **24**(9): 1003–1011, 1934.

Description of a method for the cultivation of the viruses of tobacco-mosaic and aucuba mosaic in isolated root tips grown *in vitro*.

White, Richard P[eregrine]

Diseases of ornamental plants. New Jersey Agri. Exp. Station, Circ. **226**, 98 p., 1931.

This is a popular bulletin containing brief descriptions of yellows on *Callistophus chinensis*, stunt on *Dahlia* spp., mosaic on *Gladiolus* spp. mosaic on *Iris* spp., mosaic on *Paconia officinalis*, mosaic on *Rosa* spp. mosaic on *Lathyrus odoratus*, breaking in *Tulipa* spp., and mention of mosaics on several other plants. Parts of this bulletin were published separately. See our original bibliography.

The effect of mosaic on bloom production of the Talisman rose. Phytopathology **24**(10) : 1124–1125, 1934.

Brief notes reported the effects of mosaic on the Talisman rose variety. According to the author it is of relatively slight influence from the practical viewpoint.

Whitehead, T[atham]

Immature *versus* mature seed potatoes. Journ. Mins. Agric. p. 452–455, 1930.

Contains brief notes on potato leaf roll.

Wilcox, R[aymond] B[oorman]

Identification of false blossom in the fall. Proc. Amer. Cranberry Grow. Assoc. **61** : 15–16, 1930.

Popular.

------------ **& Beckwith, C[harles] S[teward]**

A factor in the varietal resistance of cranberries to the false-blossom disease. Journ. Agric. Res. **47**(8) : 583–590, 1933.

A study of relative varietal susceptibility based on the poison formula of cranberry to the false-blossom disease.

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The false-blossom disease of cranberries. New Jersey Agric. Expt. Sta. Circ. **348**, 1935.

Wiles, D. R. D.

Report of Plant Diseases Inspector. Barbados Agric. Journ. **3**(2) : 39–44, 1934.

This report gives data on the present position of sugar-cane mosaic in Barbados.

Wilson, G. L.

Yellow stripe. Daffodil Year Book Roy. Hort. Soc. **1933** : 74, 75, 1934.

Wingard, S[amuel] A[ndrew] & Godkin, J.
Tobacco diseases in Virginia and their control. Virginia Agric. Expt. Sta. Bull. **90**, 31 p., 1924.

Bitter pit of apples. Virginia Fruit **20**: 8–10, 1932.

Woods, Albert F[red]
"Bacteriosis" of carnation. Bot. Gaz. Sept. 1897 p. 200–205, 1897.

It is admitted that the disease does not show the presence of bacteria but the causal agent is not known. The effects of aphid and thrip injuries are considered.

Stigmonose: A disease of carnation and other pinks. U.S.D.A. Div. Veg. Phy. & Path. Bull. **19**, 30 p., 1900.

The author admits that the disease is not caused by fungi nor bacteria, although no definite cause is recognized. The influence of aphis, thrips and red spiders as carriers is recognized.

Mosaic-disease study points to control by resistant varieties. U.S.D.A. Yearbook, **1927**: 464–465, 1928.

Brief popular notes.

Woods, Mark W.
Cellular changes in ring-spot. Contr. Boyce Thomp. Inst. **6** (1): 51–67, 1934.

The author describes the symptoms and gives the results of studies on the histology and cytology in the lesions.

Yenemaru, C[hutaro] & Asa, K[eijiro]
(Report of the investigations of dwarf disease of rice plant.) Kyoto Agric. Expt. Sta. Spe. Bull. 1, 178 p., 1905.

Youden, W. J., & Beale, Helen Purdy
A statistical study of the local lesion method for estimating tobacco mosaic virus. Contr. Boyce Thomp. Inst. **6**(3): 437–454, 1934.

Discussion of the subject and description of the method designed.

--------------, ------------, **& Guttine, John D.**
Relation of virus concentration to the number of lesions produced. Cont. Boyce Thompson Inst. **7**(1): 37–53, 1935.

"Data from six different sources showing lesion counts obtained by applying virus to extracts to leaves in a series of dilutions have

been assembled from the literature. The authors include work with tobacco mosaic, ring spot, cucumber mosaic, and aucuba mosaic viruses. The plants used as hosts have been *Nicotiana glutinosa*, *Phaseolus vulgaris* var. Early Golden Cluster, and *Vigna sinensis* var. Black Eye. The method of evaluating the constants is given and their possible significances discussed. The utility of the function as a guide to the design and interpretation of experiments is shown by examples.''

Zeijistra, Fzn, H. H.

Versuch einer Erklärung der ''Sereh'' Erscheinungen des Zuckerrohrs. Ber. Deutsch. Bot. Ges. **20**(6): 330–333, 1911. (Bot. Centralb. **119**(6): 151, 1912.)

Review of the work so far on this obscure disease.

Zimmermann, A[brecht Wilhelm Philipp] von

Die Kräuselkrankheit des Manioks (Mhogo). 1 und 2 Mitt. (The leaf curl of cassava.) Pflanzer, Tanga **2**: 145–153, 182–183, 1906.

Popular.

Einge Bemerkungen über, Kassave (Mhogo). (Some notes on cassava.) Pflanzer, Tanga, **2**: 257–271, 1906.

Account on botany, varieties and diseases of cassava including leaf curl.

Ueber eine Krankheit der Erdnusse. (*Arachis hypogea.*) (A disease of peanuts.) Pflanzer, Tanga, **3**: 129–133, 1907.

Notes on peanut rosette disease.

Die Deutsch—Ostafrikanischen Maniok—Varietaten (1). (Varieties of cassava in German East Africa.) Pflanzer, Tanga **3**: 258–269, 1907.

Contains reference to susceptible and resistant varieties to curl disease.

Die Kräuselkrankheit des Maniok (Mhogo) und die Abgabe gesunder Stecklinge. (The leaf curl of cassava and the delivery of healthy cuttings.) Pflanzer, Tango **5**: 184–185, 1909.

Popular.

Die Kräuselkrankheit der Erdnusse. 2 Mitt. (Rosette disease of peanuts.) Pflanzer, Daressalam **9**: 59–63, 1913.

Brief account of peanut rosette with illustrations.

Zundel, G[eorge] L[orenzo Ingram]

Rasberry diseases. Pennsylvania Agric. Expt. Sta. Circ. **133**, 20 p., 1934.

This paper includes brief practical notes on several virus diseases of the raspberry.

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7—1st—should read "La Enfermedad del Mosaico" o "Matizado" de la caña de azúcar. (Sugar cane "Mosaic" or "Mottling" disease).

8—7th—knollensarbe should read Knollenfarbe.

8—7th—bezielund should read beziehung.

9—1st—investigtion should read investigation.

9—3rd—**Alben, A. O., Cole, J[ohn] R., & Lowis, R. D.** should read **Alben, A[rthur] O[tto], Cole, J[ohn] R., & Lewis, R. D.**

9—4th—Insert Phytopathology before **22**(12):

12—2nd—**Amaral, Afranio de** should read **Amaral, A[velardo] Pompen de.**

12—2nd—Pempen de mosaico should read O mosaico.

12—3rd—**Hatton, R[oland] G[eorge]** should read **Hatton, R[onald] G[eorge].**

12—5th—Pflanzen-Schutz should read Pflanzenschutz.

23—8th—departament should read department.

25—2nd—Blatrollkrankheit should read Blattrollkrankheit.

26—8th—"Red structure" should read "Red suture".

27—4th—Landwirtschaflichen should read Landwirtschaftlichen.

27—6th—bekamft should read bekampft.

28—2nd—Kartoffell should read Kartoffel.

29—9th—insert Mitt. after Forst.

29—10th—Derseitige should read Derzseitige.

30—6th—Forest should read Forst.

31—4th—Kartoffelstanden should raed Kartoffelstauden.

31—4th—foliage should read stalks.

31—6th—Kartoffeleruten should read Kartoffellernten.

36—3rd—**1932–33**: 11 should read 1932–33, **11**: 49–70.

36—6th—A period should be inserted after bibliography.

37—1st—Moestias should read molestias.

40—6th—**M[ortimer]** should read **M[ortier].**

42—4th—Phytopathologické should read Fytopathologické.

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42—7th—infectiöse should read infektiöse.
43—1st—infectiose should read infektiose.
43—3rd—infecktiose should read infektiöse.
43—4th—*morginatae* should read *marginatæ*.
45—3rd—wirstch should read wirtsch.
45—3rd—Versuch should read **Versuchsst.**
45—3rd—Justs should read Just's.
45—5th—Veeckziek should read Vleckziek.
45—5th—Tabaklanden should read Tabaksbladen.
45—5th—Verlag should read Verslag.
45—6th—Should read Bemerkung zu dem Aufsatz von Herrn Iwanowski uber die mosaikkrankheiten der Tabakspflanze.
45 7th—insert principle after d'un.
45—7th—feulles should read feuilles.
45—7th—Achiv. should read Archiv.
45—7th—Extractes should read Exactes.
46—1st—insert der after Ursache.
46—1st—Flekenkrankheit should read Fleckenkrankheit.
46—2nd—einer should read zur.
46—9th—Proefhemingen should read Proefnemingen.
47—1st—Mogetijk should read mogelijk.
47—9th—After **125** insert 32 p.,
50—1, 2, 3—Cheshut should read Cheshunt.
51—1st—viekziekte should read vleksiekte.
51—1st—Plantutuin should read Plantentuin.
51—4th—vaie should read vraie.
54—2nd—*sativus* should read *sativum*.
56—9th—Kartoffelabbauses should read Kartoffelabbaus.
57—1st—Blattroll Krankheit should read Blattrollkrankheit.
57—3rd—Unterasuchungen should read Untersuchungen.
58—1, 2—Cheshut should read Cheshunt.
59—5th—Gebtet should read Gebiet.
59—6th—Dent. should read Deut.
59—7th—Before Gebt. insert Forsch. a. d.
60—1st—An die: should read Ans den:
60—3rd—Aüspragung should read Ausprägung.
60—3rd—vegetationsziet should read vegetationzeit.
60—3rd—Blätter Pflanzenb. n. should read Prakt. Blätter Pflanzenb. n.
60—4th—pflanzenzlicher should read pflanzicher.

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60—6th—Schädlige should read Schädlinge.
60—6th—Prakt. Blatt. Pflanzend. u. Schuts. should read Prakt. Blätt. Pflanzenb. u. Schutz.
61—1st—insert a comma after *Nicotiana tabacum.*
61—3rd—Multa should read Malta.
64—3rd—ziekt should read siekte.
64—5th—Voolooping should read Voorloopige.
64—5th—Mosaiickziekte should read Mosaickziekte.
64—8th—Pasoervean should read Pasoeroean.
65—2nd—vije should read vrije.
65—6 and 8—Uber should read Ueber.
65—7th—Bekampfungsmethoder should read Bekämpfungsmethoden.
65—7th—Forstschitte should read Fortschritte.
65—8th—verschiedner should read verschiedener.
66—1st—allgmeinen should read allegemeinen.
66—2nd—mikrocheminsche should read mikrochemische.
67—2nd—Philosolophy should read Philosophy.
67—9th—**Britton-Jones, H. R.** should read **Briton-Jones, H. R.**
71—4th—Omm virussy gdomme should read Om virus sygdomme.
73—4th—Zukerrübe should read Zuckerrübe.
75—4th—**Calinissa M. R.** should read **Calinisan, Melanio R.**
78—2nd—Is by **Carsner, Eubanks** not by **Carriers, E. A.**
78—9th—*murals* should *murale.*
80—4th—Is by **Carsner, Eubanks** not by **Carter, Walter.**
81—1st—U. S. Tech. Bull. **206**: should read U. S. D. A. Tech. Bull. **206**.
81—3rd—Ecom. should read Econ.
82—3 and 4—Are by **Carter, Walter** not by **Cayley, Dorothy M.** both are properly cited on pages 80 and 81.
82—8th—Insert and after Mosaic.
85—3rd—Sus should read Sur.
87—2nd—Should be omitted, is a repetition of the succeeding one.
87—3rd—*Epitetrix* should read *Epitrix.*
88—1st—troubies should read troubles.
90—1st—1918 should read 1917.
94—2nd—Undescribe should read Undescribed.
98—5th—degerated should read degenerated.
99—3rd—agronomical should read agronomic.
99—4th—cucious should read curious.
101—5th—Should be omitted it is not a virus disease paper.

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103—1st—Kavangeric should read Kavangerie.
105—8th—Bercht should read Bericht.
105—8th—Anftretens should read Auftretens.
105—8th—Komitees should read Kommittees.
105—8th—Land-wirtschaftlich Versuchsweseen in Oesier should read Landwirtschaftlich Versuchswesen in Oeser.
110—2nd—Zeithschrf. should read Zeitschr.
110—6th—**Demarre** should read **Demaree.**
111—9th citation—**Mc Rostie, A[ordon] P[eter]** should read **Mc Rostie, G[ordon] P[eter].**
111—11th—Omit.
113—1st—shjmisierkte should read slijmzekte.
113—8th—Canberry should read Cranberry.
118—5th—Gesundheitsszuztand should read Gesundheitszutand.
119—2, 3, 4—l'Quest should read l'Oest.
119—6th—Innoculation should read Inoculation.
119—7th—Semmis should read Semis.
123—3rd—planties dans less should read plantes dans les
125—8th—cirus should read virus.
126—2 & 3—ztechr. should read ztschr.
128—8th—**Dvorak M[ayne]** should be read **Dvorak M[ayme].**
129—1st—Zukerrubenkeimlingen should read Zuckerrubenkeimlingen.
129—1 & 2—Auzeig should read Anzeig.
129—2nd—hervorberufche should read hervorgeruende.
129—2nd—cine should read eine.
129—2nd—Viruskranheit should read Viruskrankheit.
137—5th—blattrollkankon should read Blattrollkranken.
137—6th—Organ should read Organe.
137—7th—Gas. should read Ges.
139—1st—chlorophydefekte should read Chlorophylldefekte.
146—5th—conton should read canton.
149—1st—**18**: 14–29 should read **17**: 14–29.
149—8th—March should read **11**(3): 65–69.
153—7th—tranmission should read transmission.
154—4th—*apicolis* should read *apicalis.*
154—6th—orschienene should read erschienene.
154—6th—Feiden should read Feinden.
157—8th—Tutunului should read Tutumului.
161—9th—**Peltier, Geo[ge] L[eon]** should read **Peltier, Geo[rge] L[eon].**

Page Citation
163—4th—**1924** should read **1923**.
164—5th—ealsstedets should read avlsstedets.
165—1, 2, 3—Mosaikeyge should read Mosaiksyge.
165—6th—in those non-solanaceous host should read in non- solanaceous hosts.
166—2nd—sorologique should read serologique.
168—6th—Hovard should read Howard.
170—4th—*sternbergia* should read *Sternbergia.*
173—5th—bladuizen should read bladluizen.
175—4th—untravirus should read ultravirus.
175—5th—1893 should read 1873.
176—8th—Onderzockingen should read Onderzoekingen.
177—4th—*vitrio* should read *vitro.*
178—3rd—Sortshesistens should read Sortsresistens.
179—4th—Starkeanhanfung should read Starkeanhaufung.
179—5th—Uraschen should read Ursachen.
179—5th—Kartoffelstanden should read Kartoffelstauden.
179—5th—Pflanzenzcht. should read Pflanzenzucht.
179—6th—Blattrolkrankheit should read Blattrollkrankheit.
186—4th—After **182** :insert 22 p.,
187—7th—**17**: 10–16 should read **17**: 1–16.
188—1st—Int's should read Uit's.
188—1st—Teymannia should read Teysmannia.
188—4th—Ceschouwingen should read beschouwingen.
190—4th—**Iachevskü** should read **Iachevskii.**
190—4th—Kratkü should read Kratkii.
190—4th—sostoianüa should read sostoianiia.
190—4th—uchenüa should read ucheniia.
190—4th—mikologü should read mikologii.
190—6th—Studies über eimen should read Studien über einen.
190—6th—trigheit should trahigkeit.
191—2nd—After **Viktorowitch** insert **& Polowzoff, W.**
191—2nd—sielstwo should read sredstwo.
191—2nd—Tabaspflanze should read Tabakspflanze.
191—3rd—zurie should read zwrie.
191—3rd—Inspér should read Impér.
191—7th—Pflanzendrank should read Pflanzenkrank.
192—6th—**Jackwski A[rthur] L[ouis]** should read **Jaczewski, A[rthur] L[ouis].**
196—4th—Ueberkannte Ifektionsstoffe. should read Unbekannte Infektionestoffe.

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198—8th—everwinter should read overwintering.

201—6th—After **240** insert p. 54–55,

201—11th—Omit.

203—1st—Jabresher should read Jahresber.

203—1st—Shule should read Schule.

203—4th—Plateave should read Planteavel.

203—5th—Obstr-u should read Obst-u

203—6th—onvodoenden groei should read onvoldoenden groeiën.

203—6th—rilt als gevig should read riet als gevlog.

204—4th—Forsch. should read For.

204—5th—tomosis should read tomotosis.

205—3 & 4—Krigerigheid should read Kringerigheid.

205 3rd—Landbouwhooschool should read Landbouwhoogeschool.

205—4th—pseudenetnecrosis should read pseudo-netnecrosis.

206—2nd—blattrollrankheit should read blattrollkrankheit.

206—2nd—Landro Presesse should read Landrw. Presse

206—2nd—Pflanzenkranklr. should read Pflanzenkrank.

206—8th—Ukologie should read Ökologie.

206—8th—Before Pflanzenzucht insert Pflanzenbau.

206—8th—After Pflanzenzucht insert u. Pflanzenzucht.

207—1st—German should read Germany.

207—1st—Abban should read Abbau.

207—1st—Leistungsiibers-pannungen should read Leistungsüberspannungen.

207—1st—After Pflanzenbau insert a comma.

207—2nd—inen should read innen.

207—3rd—Plant should read Planta.

207—4th—des should read der.

207—4th—Deussche should read Deutsche.

207—4th—Gesellech should read Gesellsch.

207—5th—Demonstrationen should read Demonstrations.

207—6th—Auschluss should read Ansschluss.

207—6th—Viruskrangheiten should read Viruskrankheiten.

207—6th—Plants should read Planta.

207—7th—anschluss should read ansschluss.

207—7th—be (in the annotation) should read he.

207—7th—founded should read found.

208—3rd—Ostenrop should read Osteneurop.

208—5 & 6—Kartoffelban should read Kartoffelbau.

208—6th—Forschunsinst should read Forschunssinst.

209—2nd—Bull. **23** should read Bull. **234**.

Page Citation
209—4th—Is by **Koch, G[ustav], & Kornauth, K.** not by **Kobus, J[acob] D[erk] & Bokma de Boer, B.**
209—4th—Ubertrangung should read Ubertragung.
209—5th—van should read on.
209—5th—Pflanzenschuzstation should read Pflanzenschutzstation.
209—5th—Komitees um should read Kommittees zum.
209—6th—Ztrchr. should read Ztrschr.
209—6th—**16**(3):140, 1923 should read **16**(3):89–140, 1913.
209—7th—Monattish should read Monatsh.
209—8th—dei should read bei.
210—4th—Sastgut should read Saatgut.
211—1st—Abban should read Abbau
211—1st—Kartoffelban should read Kartoffelbau.
211—3rd—**Keeslag, F. D.** should read **Koeslag, F. D.**
211—3rd—Geselch should read Geselsch.
211—5th—for Kartoffelbans should read fur Kartoffelbau.
211—6th—viruskrakheiten should read viruskrankheiten.
211—8th—Untersuchugen should read Untersuchungen.
212—2nd—au should read an.
212—2nd—Zeuschtdienst should read Pflan.
212—4th—Untersuchgen should read Untersuchungen.
212—7th—Hollandasch should read Hollandish.
213—1st—Fleckenodor should read Flecken odor.
214—2nd—Blatrollkrankheit should read Blattrollkrakheit.
214—3rd—Blattrollkranheit should read Blattrollkrankheit.
214—3rd—sightigung should read sichtigung.
214—3rd—Vervreitung should read Verbreitung.
216—2nd—Zrscht. Pfnazenkrank. should read Ztschr. Pflanzenkrank.
216—3rd—**Kraybill, Henry R[esist]** should read **Kraybill, Henry R[eist].**
216—5th—**Brewer B[earl] H[arvey]** should read **Brewer P[earl] H[arvey].**
216—7th—Physiologic should read Physiologie.
216—7th—Landow should read Landw.
216—7th—Pflanzenzan should read Pflanzenbau.
216—9th—Belenchtung should read Belechtung.
217—2nd—Zucherrohres should read Zuckerrohres.
219—9th—sida should read Sida.
221—1st—vergleichbere should read vergleichbare.
221—1st—Erscheiungen should read Erscheinungen.
221—7th—Denwl. should read Dendrol.

Page Citation

221—11th—Warwaterbehandeling should read Warmwaterbehandeling.

222—2nd—voorfgaande hegroeiing should read voorafgaande begroeiing.

223—2nd—Rech. should read Res.

223—2nd—After *Stellaria media* insert Virulent.

224—2nd—Bllattrollkrankheit should read Blattrollkrankheit.

224—8th—l'humité should read l'humidité.

227—3 & 6—Asliton should read Aston.

228—6th—those bodies should read these bodies.

229—3rd—Stuchen uber die segennante Panashure und uber einge should read Studien über die sogennante Panaschure und über einige.

229—6th—Gatenbance should read Gartenbau.

229—7th—den should read dor.

229—8th—Studies should read Studien.

229—8th—Erschenungen should read Erscheinungen.

230—7th—tabacco should tobacco.

231—1st—mikroskopich should read mikroskopisch.

231—1st—filtriebaren should read filterbaren.

231—3rd—Ledewijks should read Lodewijks.

231—6th—Is by **Loew, [Carl Benedict] Oscar** not by **Lojkin, Mary**.

232—8th—Utersuchungen uber should read Untersuchungen über.

232—8th—Kenntnuis should read kenntnis.

232—8th—Stoffwechsees should read Stoffwechsels.

239—4th—Mitteiking should read Mitteilung.

239—4th—verlanf should read verlauf.

239—4th—Forswirtsch should read Forstwirtsh.

239—7th—**Massée, G.** should read **Massee, G.**

244—1st—Mosaikrakheit should read Mosaikrankheit.

252—1st—Is by **Blood H[erbert] L[oren]** on page 56 not by **Mc Kinney, H. H.**

256—1st—*Capsicatrum* should read *Capsicastrum.*

259—6th—Kückzug should read Rückzug.

260—6th—**Milbraith D[avid] G[allens]** should read **Milbrath D[avid] G[allens]**.

262—3rd—Zukerrübe should read Zuckerrübe.

262—3rd—Zuckerrübenkranheit should read Zuckerrübenkrankheit.

262—4th—ud should read und.

262—4th—Mosaikrankheit should read Mosaikkranheit.

262—4th—Umschan should read Umschau.

Page Citation
263—2nd—Sets should read Iets.
263—3rd—nature should read natura. (In the Italian title)
264—6th—Attersschwache should read Altersschwache.
264—6th—Abban should read Abbau.
264—7th—Angeu should read Angew.
265—5th—Vechselseitige should read Wechselseitige.
265—5th—Famile should read Familie.
266—7th—Kentroll should read Kontroll.
267—4th—Zukerrübe should read Zuckerrübe.
272—4th—**Sreenivasaya, N.** should read **Sreenivasaya, M.**
273—4th—Forstwisch. should read Forstwirtschr.
274—3rd—Rudschau should read Rundschau.
277—5th—Zukerrübe should read Zuckerrübe.
277—5th—America should read Amerika.
284—5th—Kin should read Ein.
284—5th—Ertag should read Ertarg.
285—2nd—Is by **Paine, S. G., & Bewley, W. F.** not by **Pagliano, T.C.L.**
285—8th—Krankreit should read Krankheit.
286—8th—**Parker, E. R. & Horne, Wm. F.** should read **Parker E[rwin] R., & Horne, W[illiam] T[itus].**
291—1st—Recerche should read ricerca.
291.—1st—repporto should read rapporto.
291—2nd—Nuave should read Nuova.
292—2nd—infecttiva should read infettiva.
292—6th—**Hugenford** should read **Hungerford.**
293—7th—*Testranyschus* should read *Tetranyschus.*
294—4th—Omit, is repeated on page 12 where it belongs.
297—7th—precipiting should read precipitin.
298—4th—di should read die.
298—5th—Ztrchr. should read Ztschr.
299—1st—sonanceen should read solanaceen.
302—6th—Euifluss should read Einfluss.
304—1st—stact van Sland Plantentium should read stadt van S'land Plantentiun.
304—2nd—Is by **Rankin W[illiam] H[oward]** not by **Raciborski M.** insert on p. 306.
305—4th—**1926**: 26–24, should read **1926**: 24–26.
306—9th—Transfer under **Jivanna Rao, P. S.** page 195. Omit, is its right place.
307—4th—Mosaik krankheit should read Mosaikkrankheit.

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307—4th—Omit the N after Blumen.
309—10th—del should read der.
310—7th—Komitees should read Kommittees.
310—10th—Beobactilungen should read Beobanctungen.
311—1st—Ammer should read Amt.
313—7th—Erzymwirkung should read Enzymwirkung.
314—8th—**Rochlin** is also spell **Rokhlina.**
314—8th—Kartoffel pflanzen should read Kartoffelpflanzen.
317—1st—krulziekye should read krulziekte.
322—8th—Is by **Schander, R.** not by **Sauri, F.**
322—8th—Mitted should read Mittls.
323—5th—intrezellularen should read intrazellularen.
323—6th—Is by **Böning K[arl]** not by **Schaffnit, J.** Omit, is in its right place p. 59.
323—6th—wechselseitize should read wechselseitige.
324—3rd—Untersuchugen should read Untersuchungen.
324—9th—maw should read man.
325—1st—Untersuchugen should read Untersuchungen.
325—4th—insert der before Kartoffel.
325—5th—Omit Degeneration serscheinungen after andere.
325—5th—Fortwirtsch should read Forstwirtsch.
325—6th—Krauselkheit should read Krauselkrankheit.
326—3rd—**Schlumger** should read **Schlumberger.**
326—3rd—Fahre should read Jahre.
325—8th—Mossaikkrankheit should read Mosaikkrankheit.
326—9th—forschungsergebuiss should read forschungsergebris.
326—9th—ibren beziechung zum eizen should read ihren beziehung zum eisen.
326—9th—Vorlanfige voroffenlichung should read Vorläufige vorof-fenlichung.
327—1st—fescilles should read feuilles.
327—2nd—**Schribau, Emile** should read **Schribaux, Emile.**
330—4th—Atiolegie should read Aetiolegie.
339—6th—**Shepard, E[dward] F[rederick] S[isnett]** should read, **Shepherd, E[dward] F[rederick] S[isnett].**
341—7th—Nikotingenhalt should read Nikotininhalt.
342—1st—in fizierenden should read infizierenden.
351—7th—diseases should read disease (aster yellows).
353—2nd—**34** :should read **24.**
353—8th—Augabliche should read Augenbliche.
353—8th—Kartoffel-epidemic should read Kartoffel-epidemie.

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353—9th—Standpunht should read Standpunkt.
355—1st—Jaarhg, should read Jahrg.
355—2nd—Jahrbuche should read Jahrbucher.
355—3rd—mosaikrankheit bet should read mosaikkrankheit bei.
355—5th—mycrocopiques should read microscopiques.
356—2nd—Ocurrence should read Occurrence.
357—1st—dessiebrohrenkrakheit should read der siebrohrenkrankheit.
357—1st—Karfubaumes should read kafeebaumes.
357—5th—**Stahl, C[orwin] E[loyd]** should read **Stahl, C[orwin] F[loyd].**
359—2nd—Astrakham should read Astrakhan.
362—9th—Bakt I should read Bakt II.
365—7th—**6**: 89, should read **6**: 38–39,
366—1st—(*Cicadula*) should read (*Cicadulina*).
368—4th—Abban should read Abbau.
368—4th—wiederanffrischung should read wiederauffrischung.
370—1st—**Sundaranaman** should read **Sundararaman.**
370—6th—(Rickettsit-like) should read (Rickettsia-like).
370—8th—Rickttsia-like should read Rickettsia-like.
370—9th—**Swieten, H. J.** should read **Swieten, H. J. van**
371—1st—*Tetrannychus* should read *Tetranychus.*
371—3rd—**Takada** should read **Takata.**
371—3rd—Eoli should read Coll.
374—1st—**Trupp** should read **Thrupp.**
374—2nd—ondersoch should read onderzoek.
374—3rd—mitgeverd should read uitgevoerd.
374—4th—Inefectives should read Infective.
374—5th—by should read bij.
374—5th—Kulr-an should read Krul-en
374—5th—corzaken should read oorzaken.
374—5th—vors-tenandsche Tobak should read vors-otenlandsche Tabak.
375—1st—Kurl-en should read Krul-en
375—1st—cirkle should read crinkle.
377—9th—Indigége should read Indigéne.
379—3rd—Neus should read neue.
379—7th—pultivieten should read kultivierten.
382—5th—Monatschefte should read Monatshefte.

Page Citation

383—2 & 3—**Varadaraja Iyengar, A. V.** should read **Iyengar, A. V. Varadaraja** cited on page 191 where it belongs.

383—3rd—(n. d.) should read Journ. Ind. Inst. Sci. **16A**(13):137-152, 1933.

384—2nd—Plantenkieten should read Plantenziekten.

385—1st—paries should read parties.

385—1st—Bol. should read Bot.

386—3rd—viroses should read viruses.

386—3rd—After :2-10, insert (2):22-32,

389—5th—After Luft insert und

389—6th—Abvan should read Abbau.

390—1st—Budensanstalt should read Bundesanstalt.

390—1st—Pflanzenschultz should read Pflanzenschutz.

390—8th—East should read Oost.

391—1st—Unsishtbare should read unsichtbare.

391—1st—Virusfoschung should read Virusforschung.

391—1st—moghichkeit should read moglichkeit.

391—1st—Kunsthche should read Kunstliche.

391—1st—Vermeehrung should read Vermehrung.

391—1st—netravisibler should read nitchtvisibler.

393—7th—**Wedkeworth** should read **Wedgworth.**

393—8th—Missouri should read Mississippi.

894—6th—Omit Met cen Hollanden samenvatting.

394—7th—invlved should read invled.

396—6th—Klimatologye should read Klimatologie.

396—6th—Ackerbanes should read Ackerbaues.

397—1st—verreiningung should read Vereiningung.

397—10th—**Whitehead, T[athan]** should read **Whitehead T[atham].**

400—1st—Gumüsebau should read Gemüsebau.

400—2nd—Urasäche should read Ursache.

400—3rd—Umschan should read Umschau.

100—5th—grumösen should read gumösen.

400—5th—Verstofungen should Verstopfungen.

400—5th—suckerrohres should read zuckerrohres.

401—2nd—Zuckrindunst should read Zuckerind.

402—3rd—durk should read durch.

402—3rd—erzengte should read erzeugte.

403—10th—**Legman** should read **Lehman.**

404—4th—gezichtspint should read gezichtspunt.

Page Citation
404—4th—Culture should read Cultur.
404—6th—mokroflora should read mikroflora.
406—2nd—insert mosaic after potato.
409—6th—1935 should read 1931.
409—6th—Oekelogie should read Oekologie.
409—7th—Incert **von** after **P[hilipp]**.

o-O-o

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HOST INDEX OF VIRUS DISEASES OF PLANTS

MELVILLE T. COOK, *Plant Pathologist,*
Agricultural Experiment Station, Río Piedras, Puerto Rico.

The attempt to make a host index of the virus diseases of plants met with many difficulties that were not anticipated by the compiler. This was largely due to three causes: (1) the compiler did not have access to many of the original records, (2) some of the workers made incomplete (sometimes incorrect) statements in regard to previous records by other writers, and (3) many records were made before our present conception of virus diseases and are more or less unreliable. The result is that some of the records in this index are incomplete and others contain errors or may be of diseases not caused by viruses. Some virus diseases are known by more than one name as a result of being reported by students in different countries and sometimes by different writers in the same country. The number of diseases recorded in this index is not the same as the number of recognized viruses. It is well known that many viruses attack more than one species of host plants and in some cases the symptoms are different on different hosts. Furthermore, symptoms may also show variations due to other causes and are sometimes misleading. It is well known that some plants are attacked by two or more viruses, sometimes separately and sometimes in combination. Some viruses do not produce symptoms in their host under certain environmental conditions. These hosts are known as masked carriers. Some hosts never develop symptoms and are known as symptomless carriers. Sometimes two or more viruses produce the same or very similar symptoms on a specific host.

This index is not a classification of either the diseases or the viruses causing them. It is an attempt to bring the first records of each disease together for the convenience of the workers in this group of diseases. It is neither complete nor accurate. Several records have been omitted for want of complete or more accurate data. It was the intention of the compiler to insert the first records

of each disease on each host on which it occurs but this was found to be impracticable and there are some duplications.

Although we have many early records of virus diseases some of them are of very little value except for historical purposes. The research on virus diseases of plants may be considered as dating from the work on tobacco mosaic by Mayer in Europe in 1886 and the work of E. F. Smith on peach yellows in the United States in 1888. Since that time, the progress of our knowledge has been phenomenal. Up to the present time more than 5,000 papers and a few books have been published and virus diseases have been recorded in about 80 families, more than 400 genera and nearly 1,000 species of plants.

Although the agricultural industry is most interested in the diseases that attack crop plants, the studies of the past few years have demonstrated the necessity for the study of these diseases on weeds that may be carriers of these diseases and from which they may be transmitted to our economic plants and the necessity of the study of symptomless carriers and of the enfluence of environment on these viruses and the symptoms produced by them. It is very important that we should know more about the methods of transmission from year to year and from plant to plant.

A knowledge of the symptoms of virus diseases on different hosts and under different environmental conditions and the methods of transmission are very important when we consider the question of introduction of plants from one part of the world to another. When a virus diseased plant is introduced into a new home, the disease may be more or less severe than in its old home and may be transmitted to new hosts on which it may be very destructive.

This index is offered to the students of virus diseases of plants as a basis for reference work and in hopes that it will be useful in future studies. It may be corrected or extended in accordance with the ideas of the workers. If you will send the compiler your suggestions in regard to corrections and additions they will be used as far as possible in a supplement.

The compiler wishes to express his thanks to the many workers who have read this manuscript and made suggestions and corrections.

NOTE: A very few abbreviations have been used. They are U. S. for United States; N. J. for New Jersey; N. Y. for New York and D. C. for District of Columbia. Washington refers to the State of Washington. N for natural infection, I for artificial infection.

ACANTHACEAE

THUMBERGIA ALATA

Aster yellow, Kunkel, N. Y., 1931, I by *Cicadula sexnotata.*

Curly top of sugar beet. Severin & Freitag, California, 1933. I by *Eutettix tenellus.*

AIZOCEAE

MESEMBRANTHINUM CRYSTALLINUM

Celery virus I, Wellman, Florida, 1935, I.

TETRAGONIA EXPANSA

Ring spot of tobacco, Priode, N. Y., 1928, I from tobacco.

Ring spot of tobacco, Wingard, Virginia, 1928, I from tobacco.

Aster yellows, Kunkel, N. Y., 1931, I by *C. sexnotata.*

Tobacco mosaic, Grant, Wisconsin, 1934.

Celery virus I, Wellman, Florida, 1935.

AMARANTHACEAE

AMARANTHUS AURORA

Aster yellows, Kunkel, N. Y., 1926, I from *Callistephus chinensis.*

AMARANTHUS CAUDATUS

Aster yellows, Kunkel, N. Y., 1926, I from *C. chinensis.*

AMARANTHUS GRAECIZANS

Curly top of sugar beet, Carsner, California, 1919, I.

AMARANTHUS PANICULATA

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum.*

AMARATHUS RETROFLEXUS

Mosaic, Doolittle & Walker, Wisconsin, 1925, N.

AMARILIDACEAE

HIPPEASTRUM EQUESTRE

Mosaic, Kunkel, Hawaii, 1928, N.

Mosaic, Kawai, Japan, 1931.

HIPPEASTRUM JOHNSONII

Mosaic, McKinney ,Eckerson & Webb, 1923, N.

IRIS (bulbous)

Mosaic. Brierley & McWhorter, U. S., 1934. A yellow stripe and grey disease which may be the same as mosaic reported as transmissible by McWhorter in 1932.

NARCISSUS sp.
Mosaic McWhorter & Weiss, Washington, 1932, N. The disease was known previously to this date.
Darlington reported a yellow stripe in England in 1908.

NARCISSUS PSEUDONARCISSUS
Mosaic, Togashi, Japan, 1931, N.

NARCISSUS INCOMPARABILIS
Mosaic, Togashi, Japan, 1931, N.

NARCISSUS TEZATTA
Mosaic, Ogilvie, Bermuda, 1928, N.

NARCISUS TEZATTA var. CHINENSIS
Mosaic, Fukushi, Japan, 1931, N.

ANACARDIACEAE

RHUS TYPHINA
Mosaic. This disease is mentioned in the literature but the compiler has not found any definite data.

APOCYNACEAE

VINCA sp.
Rosette, Brooks, Gambia, 1932, N. Appears to be the same as on *Arachis hypogea.*

VINCA ROSEA
Aster yellows, Kunkel, N. Y., 1931, I by *C. sexnotata.*
Curly top of sugar beet, Severin & Freitag, California, 1933. I by *E. tenellus.*
Celery virus 1. Wellman, Florida, 1935, I.

ARACEAE

ANTHURIUM ANDRAENUM
Virus disease (3 types), Verplancke, Belgium, 1930, N.

ANTHURIUM SCHERZERIANUM
Virus disease (mosaic), Verplancke, Belgium, 1930, N.

CALLA sp. (cultivated)
Mosaic, McWhorter, Oregon, 1935, N.
Spotted wilt of tomato, Gardner & Whipple, California, 1935, I.

MONSTERA DELICIOSA
Virus disease. Verplancke, Belgium, 1930, I from *Anthurium.*

PHILODENDRON CORSIANUM

Virus disease, Verplancke, Belgium, 1930, I

ZANTEDESCHIA AFRICANA

Virus disease, Verplancke, Belgium, 1930, I.

ASCLEPIADACEAE

ASCLEPIAS NIVEA

Aster yellows, Kunkel, N. Y. 1926, from *C. chinensis.*

ASCLEPLAS SYRICA

Mosaic, Doolittle, Wisconsin, 1921, NI, from *Cucumis sativus.*

BALSAMINACEAE

IMPATIENS sp.

Mosaic, mentioned in the literature but the compiler did not find the original record.

BEGONIACEAE

BEGONIA sp.

Spotted wilt of tomato, Gardner, Tompkins & Whipple, 1934, I.
Aster yellows, Kunkel, N. Y., 1926, I from *C. chinensis.*

BERBERDIACEAE

BERBERIS VULGARIS

Vein mosaic, Blattny, Czechoslovakia, 1933, N.

BORAGINACEAE

ANCHUSA AZUREA

Curly top of sugar beet, Severin & Freitag, California, 1933, I by *E. tenellus.*

ANCHUSA BARRELIERI

Aster yellows, Kunkel, N. Y., 1931, by *C. sexnotata.*

ANCHUSA CAPENSIS

Aster yellows, Kunkel, N. Y., 1931, I by *C. sexnotata.*

BORAGO OFFICINALIS

Curly top of sugar beet, Severin, California, 1929, I.

CYNOGLOSSUM AMABILE

Curly top of sugar beet, Severin & Freitag, California, 1933, I by *E. tenellus.*
Tobacco mosaic, Grant, Wisconsin, 1934.

HELIOTROPIUM PERUVIANUM

Curly top of sugår beet, Severin & Freitag, California, 1933, I by *E. tenellus*.

MYOSOTIS SCORPIODES

Aster yellows, Kunkel, N. Y., 1926, I from *C. chinensis* and back.

Curly top of sugar beet, Severin & Freitag, California, 1933, I by *E. tenellus*.

MYOSOTIS SYLVATICA

Mosaic, Verplancke, Belgium, 1932, I.

BROMELIACEAE

ANANAS SATIVUS

Yellow spot, Illingworth, Hawaii, 1931, NI, observed in 1926, also attacks *Emilia flammea* and *Pisum sativus*.

Yellow spot, Carter, 1933, I. Has some character of a virus disease.

CACTACEAE

EPIPHYLLUM BRIDGESII

" HARRISONII

" HYBRIDUM RUBRUM

" ROSA AMABILIS

" SALMONEUM

" TRUNCATUM

" VIOLACEUM

PHYLLOCACTUS GAERTNERI var. MACKOYANUS

All the above are attacked by a virus disease. Reported from Germany by Pape, 1932.

EPIPHYLLUM TRUNCATUM

Mosaic, Blattny & Vukulov, Czechoslovakia, 1932, N.

CAMPANULACEAE

CAMPANULA sp.

Spotted wilt of tomato. Gardner, Tompkins & Whipple, California, 1935, N.

CAMPANULA PYRAMIDALIS

Spotted wilt of tomato, Ogilvie, England, 1932, N.

LOBELLA CARDINALIS

Spotted wilt of tomato, Holmes Smith, England, 1934.

LOBELIA ERINUS
Aster yellows, Kunkel, N. Y. I *C. sexnotata.*

TRACHELIUM sp.
Spotted wilt of tomato, Ogilvie, England, 1932, N.

TRACHELIUM CAERULEUM
Spotted wilt of tomato, Ogilvie, England, 1935.

CANNACEAE

CANNA INDICA
Mosaic, Fukushi, Japan, 1931.

CAPPARIDACEAE

CLEOME SPINOSA
Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet by *E. tenellus.*

SAMBUCUS NIGRA
Dwarf, Blattny, Czechoslovakia, 1933 N, carried by *Aphis sambuci.*

CARYOPHYLLACEAE

DIANTHUS sp.
Aster yellows, Kunkel, N. Y., 1926, I from *C. chinensis.*

DIANTHUS ALPINUS
Aster yellows, Kunkel, N. Y., 1931, I, by *C. sexnotata.*

DIANTHUS BARBATUS
Curly top of sugar beet, Severin & Freitag, California, 1933, N.

DIANTHUS CARYOPHYLLUS
Yellows, Woods, U. S. 1907, not proved to be a virus disease.
Mosaic, Fukushi & Kawai, Japan, 1932, N.
Curly top of sugar beet, Freitag & Severin, California, 1933, N. I from sugar beet by *E. tenellus.*

DIANTHUS CHINENSIS
Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet by *E. tenellus.*

DIANTHUS PLUMARIUS
Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet by *E. tenellus.*

Gypsophila paniculata

Aster yellows, Kunkel, N. Y., 1926, from *C. chinensis* and back.
Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet by *E. tenellus.*

Herniaria glabra

Aster yellows, Kunkel, N. Y., 1931, I by *C. sexnotata.*

Lychnis chalcedonica

Curly top of sugar beet, Freitag & Severin, California, 1933, I. by *E. tenellus.*

Lychnis coronaria

Aster yellows, Kunkel, N. Y., 1931 I by *C. sexnotata.*

Lychnis viscaria

Aster yellows, Kunkel, N. Y., 1931, I by *C. sexnotata.*
Celery virus 1. Wellman, Florida, 1935, I.

Polycarpon tetraphyllum

Aster yellows, Kunkel, N. Y., 1931, I by *C. sexnotata.*

Silene pendula

Aster yellows, Kunkel, N. Y., 1926, I from *C. chinensis* and back.
Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet by *E. tenellus.*

Stellaria media

Curly top of sugar beet, Carsner, California, 1919, I
Delphinium stunt, Burnett, Washington, 1934, I.
Delphinium mosaic, Heald, Washington, 1934.

Tunica saxifraga

Aster yellows, Kunkel, N. Y., 1931, I by *C. sexnotata.*

Vacaria segetalis.

Aster yellows, Kunkel, N. Y., 1931, I by *C. sexnotata.*

CELASTRACEAE

Celastrum scandens

Chlorosis, Clinton, Connecticut, 1919, N.

Evonymous japonica

Mosaic or clorosis, Bauer, Germany, 1908, N. There are several other records of chlorosis on varieties.

Evonymous radicans

Infectious chlorosis, Rischkow, Ukraine, 1927, N.

CHENOPODIACEAE

ATRIPLEX ARGENTEA
Curly top of sugar beet, Severin, California, 1919, N.

ATRIPLEX ARGENTEA EXPANSA
Curly top of sugar beet, Severin & Henderson, California, 1928. NI.

ATRIPLEX ARGENTEA HILLMANII
Curly top of sugar beet, Severin, California, 1934, I.

ATRIPLEX BRACTEOSA
Curly top of sugar beet, Severin, California, 1919, N. By inoculation, 1934.

ATRIPLEX CORDULATA
Curly top of sugar beet, Severin & Henderson, California, 1928, I.

ATRIPLEX CORONATA
Curly top of sugar beet, Severin & Henderson, California, 1928, I.

ATRIPLEX FRUCTICULOSA
Curly top of sugar beet, Severin, California 1928, I.

ATRIPLEX HORTENSIS RUBRA
Curly top of sugar beet, Severin & Henderson, California, 1934, I.

ATRIPLEX LENTIFORMIS
Curly top of sugar beet, Severin & Henderson, California, 1928, I.

ATRIPLEX PARISHII
Curly top of sugar beet, Severin & Henderson, California, 1928, I.

AGRIPLEX PATULA HASTATA
Curly top of sugar beet, Severin, California, 1928, NI.

ATRIPLEX PHYLLOSTEGIA
Curly top of sugar beet, Severin & Henderson, California, 1928, I.

ATRIPLEX ROSEA
Curly top of sugar beet, Severin, 1919, N, by inoculation, 1928.

ATRIPLEX SEMIBACCATA
Curly top of sugar beet, Severin & Henderson, California, 1928, I.

ATRIPLEX TURALENSIS
Curly top of sugar beet, Severin & Henderson, California, 1928, I.

BETA sp.

Mosaic, Prilleux & Delacroix, France, 1898, N. Reported in U. S. by Townsend, 1915.

Curly top of sugar beet, California, 1899.

Potato mosaic, van der Meulen, Holland, 1928, I.

Leaf curl, Wille, Germany, 1928, I. Also by Müller in same year.

Leaf deformity, Böning, Germany, 1930, Different from spinach blight and mosaic. Attacks spinach and *Rumex*.

BETA MARITIMA

Curly top of sugar beet, Severin & Henderson, California, 1928, NI by *E. tenellus*.

BETA VULGARIS

Encrespamiento, Fawcett, Argentine, 1925, N.

Curly top of sugar beet, Severin & Henderson, California, 1927, N, by inoculation 1928. From tomato yellows, 1927.

Ring spot of tobacco. Priode, N. Y. 1928. I from tobacco.

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum*.

Tobacco mosaic, Grant, Wisconsin, 1934, I.

BETA VULGARIS CICLA

Curly top of sugar beet, Severin & Henderson, 1928, N. I. by *E. tenellus*.

Ring spot of tobacco, Wingard, Virginia, 1928. I. From *N. tabacum*.

Celery virus 1, Wellman, Florida, 1934, I.

Tobacco mosaic, Grant, Wisconsin, 1935, I.

CHENOPODIUM ALBUM

Curly top of sugar beet, Carsner, California, 1919, I. From sugar beet.

Ring spot of tobacco, Wingard, Virginia, 1928, I from N. *tabacum*.

CHENOPODIUM AMBROSIOIDES

Curly top of sugar beet, Severin & Henderson, California, 1934, NI.

CHENOPODIUM CALIFORNICUM

Curly top of sugar beet, Severin & Henderson, California, 1928, I.

CHENOPODIUM LEPTOPHYLLUM

Curly top of sugar beet, Severin & Henderson, California, 1928, NI.

CHENOPODIUM MURALE

Curly top of sugar beet, Carsner & Stahl, California, 1924, I.
Celery virus 1, Wellman, Florida, 1935, I. Symptomless.

KOCHIA SCOPARIA var. TRICHOPHYLLA

Curly top of sugar beet, Severin & Henderson, California, 1933, NI. by *E. tenellus*.

MONOLEPIS CHENOPODIODES

Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata*.

MONOLEPIS NUTTALLIANA

Curly top of sugar beet, Severin, California, 1934, N.

SALSOLA KALI var, TENUIFOLIA

Curly top of sugar beet, Carsner, California, 1919, N.

SPINACIA OLERACEA

Spinach blight, Mc Clintock & Smith, Virginia, 1918, N. Had been know for 10 or 15 years, Hoggan (1933) reported that this host was susceptible to cucumber mosaic, sugar beet mosaic and tobacco ring spot.
Curly top of sugar beet, Carsner, California, 1919, I.
Aster yellows, Kunkel, N. Y. 1926, I from *C. chinensis*.
Leaf deformity, Böning, Germany, 1930, I.
Tobacco mosaic, Grant, Wisconsin, 1934, I.
Virus disease, Hoggan & Johnson, Wisconsin, 1935, I.
Spotted wilt of tomato, Gardner, Tompkins & Whipple, California, 1935, I.
Celerly virus 1, Wellman, Florida. 1935, I.

SUALEA MOGUINI

Curly top of sugar beet, Carsner, California, 1925, I, Very resistant.

CISTACEAE

HELIANTHEMUM CHAMAECISTUS

Aster yellows, Kunkel, N. Y., 1931, I by *C. sexnotata*.

COMMELINACEAE

COMMELINA COMMUNIS

Celery virus 1, Wellman, Florida, 1935, I.

COMMELINA LONGICAULIS

Mosaic, Cook, Puerto Rico, 1931, N.

COMMELINA NUDIFLORA

Celery mosaic, Doolittle, U. S. 1931. Appears to be same as cucumber mosaic. Wellman (1934) described it as celery virus 1.

COMPOSITAE

ACROCLINIUM ROSEUM

Aster yellows, Kunkel, N. Y. 1931, I. by *C. sexnotata.*

AGERATUM sp.

Mosaic, Rao, India, 1933, N. Rao writes of studying mosaic of *Ageratum* and *Gislkia* in relation to sandal. This is the only record that has come to the attention of the compiler.

AGERATUM CONYZOIDES

Krul or Kroepek, Thung, Java, I. Thung reports that this disease is transmitted to *N. tabacum.*

AMBROSIA ARTEMISIFOLIA

Mosaic, Chapman, Massachusetts, 1913, I from *N. tabacum.*

Aster yellows, Kunkel, N. Y. 1926. I from *C. chinensis.*

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum.*

AMBROSIA ELATIOR (*sarmemisiifolia*)

Celery virus 1, Wellman, Florida, 1934, I by *Aphis gossypii.*

AMBROSIA TRIFIDA

Aster yellows, Kunkel, N. Y. 1926, I from *C. chinensis* and back.

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum.*

AMMOBIUM ALATUM

Aster yellows, Kunkel, N. Y. 1926, I from *C. chinensis* and back.

ANTHEMIS COTULA

Delphinium mosaic. Heald. Washington, 1934. A symptomless carrier.

Delphinium stunt, Burnett, Washington, 1934, I.

Curly top of sugar beet, Severin, California, 1934, I.

ANTHEMIS DIVICA

Mosaic, Verplancke, Belgium, 1932, I.

ANTHEMIS TINCTORIA

Aster yellows, Kunkel, N. Y. 1931, I. by *C. sexnotata.*

ARCTOTIS GRANDIS

Aster yellows, Kunkel, N. Y. 1931, I. by *C. sexnotata.*

ARCTOTIS STOECHADIFOLIA

Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet by *E. tenellus.*

ASTER sp.

Spotted wilt of tomato, K. M. Smith, England, 1932, I.

ASTER LEAVIS

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum.*

BAERIA ULIGINOSA

Curly top of sugar beet, Severin, California, 1934, N.

BELLIS PERENNIS

Aster yellows, Kunkel, N. Y. 1926, I from *C. chinensis* and back.
Mosaic, Verplancke, Belgium, 1932, I.
Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet by *E. tenellus.*

BIDENS DISCOIDEA

Ring spot of tobacco, Wingard, Virginia, 1928, I. From *N. tabacum.*

BRACHYCOME IBERIDIFOLIA

Aster yellows, N. Y. 1926, I from *C. chinensis* and back.
Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet by *E. tenellus.*

CACALIA HASTATA

Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

CALENDULA sp.

Rosette, Brooks, Gambia, 1932, N. Similar to rosette on *Arachis hypogea.*

CALENDULA ARVENSIS

Mosaic, Verplancke, Belgium, 1932, I.

CALENDULA OFFICINALIS

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum.*
Aster yellows, Kunkel, N. Y. 1926, I from *C. chinensis* and back.
Yellows, Fukushi, Japan, 1930, N.

Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet by *E. tenellus.*

Spotted wilt of tomato, Pittman, Australia, 1934, N. Mild form.

CALLIOPSIS sp. (COREOPSIS)

Aster yellows, Kunkel, N. Y. 1926, I.

Rosette, Brooks, Gambia, 1932, N. Similar to resette of *A. hypogea.*

CALLIOPSIS DRUMMONDI

Spotted wilt of tomato. Pittman, Australia, 1934, N.

CALLISTEPHUS CHINENSIS

Aster yellows, Smith, Massachusetts, 1902, N. First record.

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum.*

Yellows, Fukushi, Japan, 1929.

Spotted wilt of tomato, Pittman, Australia, 1934, N.

California aster yellows, Severin, California, 1929, I.

CARTHAMUS TINCTORIUS

Aster yellows, Kunkel, N. Y., 1931, by *C. sexnotata.*

CENTAUREA AMERICANA

Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet by *E. tenellus.*

CENTAUREA CYANUS

Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet by *E. tenellus.*

CENTAUREA IMPERIALIS

Aster yellows, Kunkel, N. Y. 1926, I from *C. chinensis* and back.

CENTAUREA MARGARITAE

Aster yellows, Kunkel, N. Y. 1926, I from *C. chinensis* and back.

CENTAUREA MOSCHATA

Curly top of sugar beet, Freitag & Severin, California,: 1933, I from sugar beet by *E. tenellus.*

CHARIEIS HETEROPHILLA

Aster yellows, Kunkel, N. Y., 1931, I by *C. sexnotata.*

CHRYSANTHEMUM sp.

Yellows, Nelson, Michigan, 1925, N. Resembles, aster yellows.

Spotted wilt of tomato, Ainsworth, England, 1934, I.

Chrysanthemum cinerariaefolium
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

Chrysanthemum coronarium
Aster yellows, Kunkel, N. Y. 1926, I by *C. chinensis.*
Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet by *E. tenellus.*

Chrysanthemum frutescens
Aster yellows, Kunkel, N. Y. 1926, I from *C. chinensis* and back.
Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet by *E. tenellus.*

Chrysanthemum leucanthemum
Aster yellows, Kunkel, N. Y. 1926, I from *C. chinensis* and back.

Chrysanthemum maximum
Aster yellows, Kunkel, N. Y. 1925, I from *C. chinensis.*

Chrysanthemum parthenium
Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet.

Chrysanthemum segetum
California aster yellows, Freitag & Severin, California, 1934, N.

Cichorium intybus
Mosaic, Marchal, Belgium, 1931, N.

Cineraria sp.
Mosaic & Dwarfing, Dickson, Canada, 1920, N.
Spotted wilt of tomato, Gardener, Tompkins, & Whipple, California, 1935, I

Cineraria hybrida
Aster yellows, Kunkel, N. Y., 1931, by *C. sexnotata.*

Cirsium oleraceum
Aster yellows, Kunkel, N. Y., 1931, by *C. sexnotata.*

Cladanthus arabicus
Aster yellows, Kunkel, N. Y., 1931, by *C. sexnotata.*

Cosmidium sp.
Aster yellows, Kunkel, N. Y., 1926, I from *C. chinensis.*

Cosmidium sp. (-Thelesperma)
Aster yellows, Kunkel, N. Y. 1925, I from *C. chinensis* and back.

COSMUS sp.

Spotted wilt of tomato, Pittman, Australia, 1934, N. mild form.

COSMUS BIPINNATUS

Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet by *E. tenellus.*

COSMUS HYBRIDA

Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet by *E. tenellus.*

COREOPSIS LANCEOLATA

Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

COREOPSIS TINCTORIA

Curly top of sugar beet, Severin & Freitag, California, 1933. NI from sugar beet by *E. tenellus.*

COUSINIA HYSTRIX

Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

DAHLIA sp.

Spotted wilt of tomato, K. M. Smith, England, 1932, I.
Rugose rosette, Brierley, N. Y. 1933.
Rugose mosaic, Brierley, N. Y. 1933.
Ring spot, Brierley, N. Y. 1933.
Yellow ring spot, Brierley, N. Y. 1933.
Dwarf, Brierley, N. Y., 1933.
Veinal mosaic, Brierley, N. Y., 1933.
Oakleaf, Brierley, N. Y., 1933.
Streak, Campbell, England, 1934, N.

DAHLIA VARIABILIS

Mosaic, Norton, Maryland, 1909, N. Attacks all species. The same or a similar disease occurs in Germany. Brandenbourg (1929) reported two types.

Oak leaf, Brierley, N. Y. 1932, N.

DIMORPHOTHECA AURANTIACA

Aster yellows, Kunkel, N. Y., 1926, I from *C. chinensis* and back.

Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet, by *E. tenellus.*

ECHINOPS DAHURICUS

Aster yellows, Kunkel N. Y. 1931, I by *C. sexnotata.*

EMILIA sp.
Spotted wilt of tomato, Gardner & Whipple, California, 1935, I.

EMILIA FLAMMEA (-SAGITTATA)
Yellow spot of pineapple, Lindford, Hawaii 1931, NI. This host shows both a ring spot and a mosaic. *Thrips tobacci* from these plants produce yellow spots on pineapple.
Tobacco mosaic, Grant, Wisconsin, 1934, I.

EMILIA SAGITTATA (-FLAMMEA)
Celery virus 1, Wellman, 1934, I.

ERIGERON, ANNUUS
Aster yellows, Kunkel, N. Y., 1926, I from *C. chinensis* and back.
Yellows, Kanegae, Japan, 1929.

ERIGERON CANADENSIS
Aster yellows, Kunkel, N. Y., 1926, I from *C. chinensis* and back.
Yellows, Waite, Tennessee, 1907, N. Appears to be the first record.
Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum*.

ERIGERON GLABELLUS
Aster yellows, Kunkel, N. Y. 1931, by *C. sexnotata*.

ERIGERON LINEFOLIUS
Aster yellows, Kunkel, N. Y. 1931, by *C. sexnotata*.

ERIGERON SPECIOSUS
Aster yellows, Kunkel, N. Y. 1931, by *C. sexnotata*.

ETHULIA CONYZOIDES
Aster yellows, Kunkel, N. Y. 1931, I. by *C. sexnotata*.

EUPATORIUM PERFOLIATUM
Aster yellows, Kunkel, N. Y. 1931, I. by *C. sexnotata*.

EUPARIUM URTICAEFOLIUM
Aster yellows, Kunkel, N. Y. 1931, I. by *C. sexnotata*.

FELICIA AETHIOPICA var. GLANDULOSA
Aster yellows, Kunkel, N. Y. 1931, I. by *C. sexnotata*.

FELICIA AMELLOIDES
Aster yellows, Kunkel, N. Y. 1931, I. by *C. sexnotata*.

FILAGO GERMANICA
Aster yellows, Kunkel, N. Y. 1931, I. by *C. sexnotata*.

FLAVERIA REPANDA
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

GALINSOGA PARVIFLORA
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*
Mosaic, Verplancke, Belgium, 1932, I.

GALLARDIA ARISTATA
Aster yellows, Kunkel, N. Y. 1926, I.

GNAPHALIUM CHILENSE
Curly top of sugar beet, Severin, California, 1933, I.

GRINDELIA SQUARROSA
Curly top of sugar beet, Kunkel, N. Y. 1931, I by *C. sexnotata.*

HEDYPNOIS CRETICA
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

HELENIUM AUTUMNALE
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

HELENIUM BIGLOVII
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

HELENIUM HOOPESSI
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

HELENIUM NUDIFLORIUM
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

HELIANTHUS ANNUUS
Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum.*

HELICHRYSIUM BRACTEATUM
Curly top of sugar beet, Freitag & Severin, California, 1933, NI.
California Aster yellows, Freitag & Severin, California, 1934, from sugar beet by *E. tenellus.*

HELIANTHUS DEBILIS
Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet, by *E. tenellus.*

HELIANTHUS DECAPETALUS
Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet by *E. tenellus..*

HELECHRYSUM ARENARIUM
Aster yellows, Kunkel, NI, 1926, I from *C. chinensis.*

HELIOPSIS LAEVIS

Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

HELIOPSIS SCABRA

Mosaic, Elmer, Iowa, 1925.

HELIPTERUM MANGLESII

Aster yellows, Kunkel, N. Y., 1931, I from *C. sexnotata.*

HELIPTERUM ROSEUM

Curly top of sugar beet, Freitag, & Severin, California, 1933, I from sugar beet by *E. tenellus.*

HERACIUM ALPINUM

Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

HYPOCHAERIS RADICATA

Mosaic, Pantanelli, Italy, 1920, N.

KOELPINIA LINEARIS

Aster yellows, Kunkel, N. Y. 1931, NI by *C. sexnotata.*

LACTUCA SATIVA

Mosaic, Jagger, Florida, 1921, N., Nishimura (1932) made inoculations from *Asclepias syriaca* and *Rumex britanica* and back.

Aster yellows, Kunkel, N. Y. 1926. I from *C. chinensis.*

Mosaic, Fukushi, Japan, 1928.

Rio Grande disease (-white heart and rabbit ear) Carpenter, Texas, 1916, N.

Spotted wilt of tomato, Tompkins & Gardener, California, 1934, NI.

LACTUCA SATIVA, var, CAPITATA

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum.*

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum.*

California aster. yellows, Severin, California, 1929, NI.

LECTUCA SCARIOLA

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum.*

Delphinium stunt, Burnett, Washington, 1934, I.

Delphinium virus, Heald, Washington, 1934, I, Dwarfing, Curling and mottling.

Big vein, Jagger & Chandler, California, 1934, I. Observed previously. Not proved to be a virus but is similar to the soil borne mosaic of wheat.

LAGASCAEA MOLLIS
Aster yellows, Kunkel, N. Y., 1931, I from *C. sexnotata.*

LAYIA sp.
Spotted wilt of tomato, Gardner, Tompkins, & Whipple, California, 1935, I

LAPPA (ARCTIUM) sp.
Feather leaf, Shapiro, Ukraine, 1934, I.

LEONTODON AUTOMALIS
Yellow disease, Morse, Maine, 1908, I.
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

LEONTOPODIUM ALPINUM
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

LEPTOSYNE STILLMANI
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

LINDHEIMERIA TEXANA
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

LEONAS INODORA
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

MATRICARIA ALBA
Aster yellows, Kunkel, N. Y. 1925, I from *C. chinensis.*

MATRICARIA INODORA
Curly top of sugar beet, Freitag & Severin, California, I from sugar beet by *E. tenellus.*

MICROSERIA DOUGLASII
Curly top of sugar beet, Severin, California, 1934, N.

MULGEDIUM ALPINUM
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

PARTHENIUM INTEGRIFOLIUM
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

PETASITES ALBUS
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

PYRETHRUM sp.
Aster yellows, Kunkel, N. Y., 1926, from *C. chinensis*.

RUDBECKIA HIRTA
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata*.

SANVITALIA PROCUMBENS
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata*.

SCHKUHRIA ABROTANOIDES
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata*.

SCOLYMUS HISPANICUS
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata*.

SENECIO VULGARIS
Mosaic, Verplancke, Belgium, 1932, I
Curly top of sugar beet, Severin, California, 1934, I.

SONCHUS ARVENSIS
Aster yellows, Kunkel, N. Y. 1926, NI from *C. chinensis* and back.

SONCHUS ASPER
Curly top of sugar beet, Severin, California, 1934, NI.

SONCHUS OLERACEUS
Aster yellows, Kunkel, N. Y., 1926, NI from *C. chinensis* and back.
Curly top of sugar beet, Severin, California, 1934, I.

SPILANTHES ACMELIA
Aster yellow, Kunkel, N. Y. 1931, NI by *C. sexnotata*.

STOKESIA LAEVIS
Mosaic, Elmer, Iowa, 1924, N.

SYNEDRELLA NODIFLORA
Krul or Kroepoek, Thung, Java, 1934, N.

TAGETES ERECTA
Aster yellows, Kunkel, N. Y. 1926, I from *C. chinensis*. Probably same as celery yellows, white heart, rabbit ear and Río Grande diseases, Severin (California, 1929) reported celery yellows, inoculated from celery.
Rings spot of tobacco. Wingard, Virginia, 1923, I, from *N. tabacum*.
Kroepoek, Thung, Java, 1932, I. Also on *N. tabacum*.

Curly top of sugar beet, Severin & Freitag, California, 1931, N.
Delphinium mosaic, Heald, Washington, 1934, I. Dwarfing.
Celery virus 1, Wellman, Florida, 1934, I.
Curly top of sugar beet, Freitag & Severin, California, 1933, NI from sugar beet by *E. tenellus.*
California aster yellows, Severin & Freitag, California, 1934, N celerly virus, Wellman, Florida, 1935, I.

TAGETES PATULA
Curly top of sugar beet, Freitag & Severin, California, I from sugar beet by *E. tenellus.*
Tobacco mosaic, Grant, Wisconsin, 1934, I.
Celery virus 1, Wellman, Florida, 1934, I.
California aster yellows, Severin & Freitag, California, 1934, I.

TARAXACUM OFFICINALIS
Aster yellows, Kunkel, N. Y. 1926, I from *C. chinensis* and back.

TARAXACUM PLATICARPUM
Yellows, Fukushi, Japan, 1929.

TUSSIDAGO FARFARA
Potato mosaic, van der Meulen, Holland, 1928, I.

THELESPERMA HYBRIDUM
Aster yellows, Kunkel, N. Y. 1931, I from *C. chinensis.*

THITHONIA DIVERSIFOLIA
A virus disease, van der Bijl, South Africa, 1931.

TOLPIS BARBATA
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

TRAGOPOGON FLOCCOSES
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

TRAGOPOGON PORRIFOLIUS
Aster yellows, Kunkel, N. Y. 1926, I from *C. chinensis.*

TRIDAX TRILOBATA
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

TROXIMON GLAUCUM
Aster yellows, Palm, Sweden, 1933.

URSINIA ARTHEMOIDES
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

VERBESINA ALTEMIFOLIA

Ring spot of tobacco, Henderson & Wingard, Virginia, 1931, NI by insects.

XANTHIUM SPINOSUM

Curly top of sugar beet, Severin, California, 1934, NI.

ZACYNTHA VERUCOSA

Aster yellows, Kunkel, N. Y. 1931, by *C. sexnotata.*

ZINNIA sp.

Leaf curl of cotton, Mathur, India, 1932.
Spotted wilt of tomato. England, 1932, I.
Delphinium stunt. Burnett. Washington, 1931, I.

ZINNIA ELEGANS

Mosaic, Elmer, Iowa, 1924, N.
Mosaic, Fukushi, Japan, 1927.
Ring spot of tobacco, Wingard, Virginia, 1928, I, from *N. tobacum.*
Aster yellows, Severin, California, 1929, I. May be same as white heart, rabbit ear and Río Grande disease of lettuce.
Said to attack, *Apium repaceum, Plantago major.*
Tobacco mosaic. Grant, Wisconsin, 1934, I.

ZINNIA MULTIFLORA

Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

CONVOLVULACEAE

CONVOLVULUS ARVENSIS

Mosaic, Blattny, Cezechoslovakia, 1930. Carried by *Aphis* sp. and larva of *Nematus ventriculosus.*
Spotted wilt of tomato, Green, England, 1935.

IPOMOEA BATATAS

Mosaic, Ensign, Arkansas, 1919, N. Also reported by Rosen who found the disease in 1918.
Celery virus 1, Wellman, Florida, 1935, I.

IPMOEA NIL

Mosaic, Cook, Puerto Rico, 1931, N.

IPOMOEA PURPUREA

Tobacco ring spot, Wingard, Virginia, 1928, from *N. tabacum.*
Celery virus 1, Wellman, Florida, 1935. I.

IPMOEA° SETOSA

Curly top of sugar beet, Freitag & Severin, California, 1935, from sugar beet by *E. tenellus*.

IPOMOEA TRICOLOR

Tobacco mosaic, Grant, Wisconsin, 1934, I.

QUAMOCLIT LOBATA

Curly top of sugar beet. Freitag & Severin, California, 1933, I.

QUAMOCLIT PENNATA

Tobacco mosaic, Grant, Wisconsin, 1934, I.

CRUCIFERAE

ALYSSUM COMPACTUM PROCUMBENS

Aster yellows, Kunkel, N. Y., 1926, I from *C. chinensis*.

ARMORACIA RUSTICANA

Curly top of sugar beet, Severin, California, 1917, I, by *E. tenellus*.

A virus disease by Hoggan & Johnson, Wisconsin, 1935, N.

BARBAREA BARBAREA

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum*.

BRASSICA sp.

Virus disease, K. M. Smith, England, 1935, N.

BRASSICA ALBA

Mosaic, Clayton, Long Island, 1930, N.

Tobacco Mosaic, Grant, Wisconsin, 1934, N.

Curly top of sugar beet, Severin, California, 1929, I.

BRASSICA ARVENSIS

Curly top of sugar beet, Severin, California, 1934, NI.

BRASSICA CAMPESTRIS

Mosaic, Gardner, Indiana, 1921, N.

BRASSICA CHINENSIS

Mosaic, Schultz, U. S., 1921, N.

BRASSICA JAPONICA

Mosaic, Schultz, U. S., 1921, N.

BRASSICA NAPOBRASSICA

Mosaic, Clayton, Long Island, 1930, N.

Brassica napus
Mosaic, Clayton, Long Island, 1930, N.

Brassica nigra
Mosaic, Clayton, Long Island, 1930, N.
Virus disease, Hoggan & Johnson, Wisconsin, 1935, N.

Brassica nigra acephala
Virus disease, Tompkins, California, 1934, I.

Brassica nigra botrytis
Virus disease, Tompkins, California, 1934, N.

Brassica nigra capitata
Curly top of sugar beet, Severin, California, 1929, I.
Virus disease, Tompkins, California, 1934, I, and Hoggan & Johnson, Wisconsin, 1935, N.
Spotted wilt of tomato, Gardner, Tompkins, & Whipple, California, 1935, I.

Brassica oleracea acephala
Curly top of sugar beet, Severin, California, 1929, I.

Brassica oleracea botrytis
Curly top of sugar beet, Severin, California, 1929, I.

Brassica oleracea capitata
Curly top of sugar beet, Severin, California, 1929, NI.

Brassica pepinensis
Mosaic, Schultz, U. S. 1921, N.

Brassica pe-tsai
Mosaic, Takimoto, Japan, 1927, N.

Brassica rapa
Tobacco mosaic, Grant, Wisconsin, 1934, I.
Mosaic, Schultz, U. S. 1921, I.
Curly top of sugar beet, Severin, California, 1929.
Celery virus, 1, Wellman, Florida, 1935, I.

Capsella bursa-pastoris
Curly top of sugar beet, Severin, 1929, NI.
Delphinium mosaic, Heald, Washington, 1934, I. Symptomless carrier.
Delphinum stunt, Burnett, Washington, 1934, I.

CHEIRANTHUS sp.

Spotted wilt of tomato, Gardner, Tompkins & Whipple, California, 1935, I.

CHEIRANTHUS ALLIONII

Aster yellows, Kunkel, N. Y. 1931, I, by *C. sexnotata.*

HESPERIS MATRONALIS

Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet by *E. tenellus.*

IBERIS UMBELLATA

Curly top of sugar beet, Freitag, California, 1933, I, from sugar beet by *E. tenellus.*

ISATIS TINCTORIA

Mosaic, Soriano, Argentina, 1932, N.

LEPIDIUM NITIDUM

Curly top of sugar beet, Freitag & Severin, California, 1934, N.

LUNARIA ANNUA

Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet and back.

MALCOMIA MARITIMA

Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

MATHIOLA INCANA

Curly top of sugar beet, Freitag & Severin, California, 1934, I, from sugar beet by *E. tenellus.* Also with the variety *annua.*

RADICULA SYLVESTRIS

Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

RAPHANUM MACROPODA

Mosaic, Takimoto, Japan, 1927, N.

RAPHANUM RAPHANISTRUM

Virus diseases, van der Bijl, South Africa, 1931, N.

RAPHANUS SATIVUS

Mosaic, Kulkarni India, 1924.

Mosaic, Gardner, Indiana, 1925.

Curly top of sugar beet, Severin, California, 1927, NI by *E. tenellus.*

SINAPSIS sp.

Mosaic, Takimoto, Japan, 1927, N.

SINAPSIS (BRASSICA) ALBA

Potato mosaic, van der Meulen, Holland, 1928, I.

SINAPSIS ARVENSIS

Mosaic, Gram, Denmark, 1925, N. Also observed the disease on related plants.

THELYPODIUM LASIOPHYLLUM

Curly top of sugar beet, Severin, California, 1934, N.

CUCURBITACEAE

BENINCASA CERIFERA

Mosaic, Doolittle & Walker, Wisconsin, 1925.

BENINCASA HISPIDA

Mosaic (White pickel), Jagger, U. S., 1918 I from *C. sativus*

BRYONOPSIS LACINIESSA

Mosaic, Doolittle & Walker, Wisconsin, 1925.

CHAYOTE EDULIS

Celery virus 1, Wellman, Florida, 1935, I. Symptomless.

CITRULLUS VULGARIS

Mosaic, Doolitte, Wisconsin, 1925, I from *C. sativus*.

Mosaic (White pickel) Jagger, U. S. 1918, I from *C. sativus*.

Curly top of sugar beet, Severin, California, 1928, N.

Ring spot of tobacco, Wingard, Virginia, 1927, I from *N. tabacum*.

Bettendorf mosaic, Porter, Iowa, 1931.

Green mottle mosaic (Virus 3,) Ainsworth, England, 1935, I from *C. sativus*.

Yellow mosaic (virus 4) Ainsworth, England, 1935.

Celery virus 2, Wellman, Florida, 1934, I.

CUCUMIS ANGURIA

Mosaic (white pickel) Jagger, U. S. 1918, I.

Bettendorf mosaic, Porter, Iowa, 1931. Also attacks chinese long, water melon and citron.

Cucumber mosaic (3 types), Johnson, Kentucky, 1930.

Mosaic, Doolittle & Walker, Wisconsin, 1925, I from *C. sativus*

Celery virus 1, Wellman, Florida, 1935, I.

Green mottle mosaic, (virus 3). Ainsworth, England, 1935, I.

Yellow mottle mosaic (virus 1), Ainsworth, England, 1935, I.

CUCUMIS FILICIFOLIA

Mosaic, Doolittle, Wisconsin, 1925, I.

CUCUMIS GROSSULARIAE FORMIS

Mosaic Doolittle, Wisconsin, 1925. I.

CUCUMIS MADERSPATANUS

Green mottle mosaic (virus 3), Ainsworth, England, 1935, I, from *C. sativus.*

Yellow mottle mosaic, (virus 1), Ainsworth, England, 1935, I from *C. sativus.*

CUCUMIS MELO

Chlorosis, Clinton, Connecticut, 1908, N. Also on squash and muskmelon.

Mosaic (white pickel). Jagger, U. S. 1918, I from *C. sativus.*

Mosaic, Doolittle, U. S. 1925, NI from *C. sativus.* Also on varieties *dudain, fexuosus* & *utilissima.*

Mosaic, Fukushi, Japan, 1928. On var. *conomon,* Hori, Japan, 1922.

Celery virus 1, Wellman, Florida, 1934, N.

Green mottle mosaic (virus 3) Ainsworth, England, 1935, I.

Yellow mosaic (virus 4), Ainsworth, England, 1935, I.

Yellow mosaic (virus 1) Wellman, Florida, 1935, I.

CUCUMIS MELO CANTALUPENSIS

Curly top of sugar beet, Severin, California, 1927, N.

Ring spot of tobacco, Wingard, Virginia, 1928, NI from *N. tabacum* and back.

CUCUMIS MELO INDODORUS

Curly top of sugar beet, Severin & Henderson, California, 1928, N.

CUCUMIS MELO RETICULATUS

Curly top of sugar beet, Severin & Henderson, California, 1928, NI.

CUCUMIS METALLIFERUS

Mosaic, Doolittle, U. S. 1925, N.

CUCUMIS MOSCHATA

Mosaic, Doolittle & Walker, Wisconsin, 1925, from *C. sativus.*

CUCUMIS ODORATISSIMUS

Mosaic Doolittle & Walker, Wisconsin, 1925, I from *C. sativus.*

CUCUMIS SATIVUS

First record by Selby in Ohio in 1902. Many later records which may or may not be same, Walker (1925) reported inoculation from *Physalis sublabrata* & *P. heterophylla*;

Elmer (1925) from *P. vulgaris, Apium graveolens* and *Euphorbia perslii;* Doolitle & Walker (1925) from *Capiscum annuum* and *Amaranthus retroflexus;* and Walker (1925) from *Phytolacca decandra.*

White pickel, Clinton, Connecticut, 1915, N.

Mosaic (on leaves only) Jagger, U. S. 1917, N.

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum* and back.

Mosaic, Hori, Japan, 1912.

Curly top of sugar beet. Severin, California, 1928, NI.

Cucumber mosaic, Johnson, Kentucky, 1930, NI from *N. tabacum, C. sativus, Asclepias syrica.* Reports three distinct strains of cucumber virus.

Bettendorf mosaic, Porter, Iowa, 1930, I.

Healthy tobacco mosaic, Johnson, Kentucky, 1930.

Mild tomato mosaic (a single virus or combination of tomato and tobacco mosaic viruses.), Ainsworth England, 1933, I.

Delphinium virus, Heald, Washington, 1934, I.

Delphinium stunt, Burnett, Washington, 1934, I.

Green mottle mosaic (virus 3) Ainsworth, England, 1935. NI

Yellow mosaic (virus 4), Ainsworth, England, 1935, NI, from *C. sativus* and *N. tabacum.*

Yellow mottle mosaic (virus 1). Ainsworth, England 1935, NI from *C. sativus* to *N. tabacum.*

Celery virus, Wellman, Florida, 1935. I.

CUCURBITA sp.

Curly top of sugar beet, McKay & Dykstra, Oregon, 1927, I by *E. tenellus.*

CUCURBITA MAXIMA

Mosaic or white pickel, Jagger, U. S. 1918, I from *C. sativus.*

Curly top of sugar beet, Severin & Henderson, California, 1928, N.

Celerly virus 1. Wellman, Florida, 1935, I.

CUCURBITA MOSCHATA

Mosaic or white picked, Jagger, U. S. 1918, I from *C. sativus.*

Mosaic, Elmer, Iowa, 1924, I. *Lycopersicon esculentum* and *N. tabacum.*

Curly top of sugar beet, Severin & Henderson, California, 1928, I.

Ring spot of tobacco, Wingard, Virginia, 1928 from *N. tabacum.*

Mosaic, Fukushi, Japan, 1928 and Nakata et al, Korea, 1928.

CUCURBITA PEPO

Mosaic or white pickel, Jagger, U. S. 1918, I from *C. sativus.*

Mosaic, Doolittle, U. S., 1925, N. By inoculation from *N. tabacum* by Elmer, 1925.

Curly top of sugar beet, Freitag & Severin. California, 1925, NI from sugar beet. By *E. tenellus.*

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum.*

Yellow mottle mosaic, (virus 1). Ainsworth, England, 1935, I from *C. sativus.*

Celery virus 1, Wellman, Florida, 1935, I.

CUCURBITA PEPO var. CONDENSA

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum.*

Celerly virus L. Wellman, Florida, 1935, I.

CUCURBITA PEPO var. OVIFERA

Ring spot of tobacco Wingard, Virginia, 1928, I from *N. tabacum.*

ECBALLIUM ELETARIUM

Mosaic, Doolittle. Wisconsin, 1925, N.

LAGENARIA LEUCANTHA

Mosaic, Doolittle, & Walker, Wisconsin, 1925, I from *C. sativus.*

Ring Spot, Wingard, Virginia, 1928, I from *N. tabacum.*

Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet by *E. tenellus.*

LAGENARIA VULGARIS

Mosaic or white pickel, Jagger, U. S. 1918, I from *C. sativus.*

LAGENARIA VULGARIS, var. ELEVATA

Mosaic, Hori, Japan, 1922.

LUFFA sp.

Mosaic or white pickel, Jagger, U. S. 1918, I from *C. sativus.*

LUFFA ACUTANGULIS

Mosaic, Doolittle, U. S. 1925, N. By inoculation from *C. sativus* by Doolittle and Walker, Wisconsin, 1925.

LUFFA CYLINDRICA

Mosaic, by inoculation from *C. sativus,* by Doolittle & Walker, Wisconsin, 1925.

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum.*

Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar best by *E. tenellus.*

MELOTHIA SCABRA

Mosaic or white pickel, Jagger, U. S. 1918, I from *C. sativus.*

MICRAMPELIS LOBATA

Mosaic, Doolittle, Wisconsin, 1925, U. S., N.

MOMORDICA BALSAMINA

Mosaic or white pickel, Jagger, U. S. 1918, I from *C. sativus.*

MOMORDICA CHARANTIA

Mosaic, Doolittle, & Walker, Wisconsin, 1925, 1 from *C. sativus.*

MOMORDICA INVOLUERATA

Mosaic, Doolittle & Walker, Wisconsin, 1925, I from *C. sativus.*

SICYOS ANGULATUS

Mosaic, Doolittle & Walker, Wisconsin, 1925, I from *C. sativus.*

TRICHOSANTHES sp.

Bettendorf mosaic, Porter, Iowa, 1930, N.

TRICHOSANTHES ANGUINA

Mosaic, Doolittle, Wisconsin, 1925, N.

Curly top of sugar beet, Freitag & Severin, California, 1933. I from sugar beet by *E. tenellus.*

TRICHOSANTHES CUCUMEROIDES

Mosaic, Kasai, Japan, 1924.

DATISCACEAE

DATISCA CANNABINA

Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

DIPSACACEAE

SCABIOSA sp.

Spotted wilt of tomato, Pittman, Australia, 1934, N.

SCABIOSA ATROPURPUREA

Aster yellows, Kunkel, N. Y. 1926, I.

Ring spot of tobacco, Wingard, Virginia, 1929, I from *N. tabacum.*

Curly top of sugar beet, Severin & Freitag, California, 1933, N.

Celery virus 1, Wellman, Florida, 1935, I.

ERICACEAE

RHODODENDRON sp.
Mosaic Pape, Germany, 1931.

VACCINIUM MACROCARPON
False blossom of cranberry, Shear, Wisconsin, 1907, N. Cause not known for many years.

EUPHORBIACEAE

ADENOROPIUM GOSSYPIFOLIUM
Mosaic, Cook, Puerto Rico, N.

EUPHORBIA HELIOSCOPIA
Mosaic & Yellows, Verplancke, Belgium, 1932, N.

EUPHORBIA MARGINATA
Curly top of sugar beet, Freitag & Severin, California, 1933. I, from sugar beet by *E. tenellus.*

EUPHORBIA PEPLUS
Curly top of sugar beet, Severin, California, 1934, I.

EUPHORBIA PULCHENIMA
Leaf curl, Pape, Germany, 1934.

MANIHOT sp.
Mosaic, McKinney, West Coast Africa, 1929,N.
Mosaic, Dade, Gold Coast, 1926, N.
A second mosaic, Kufferath & Ghésquire, Belgian Congo, 1932. N.

MANIHOT DULCIS
Mosaic, Joly, Northern Africa, 1931, N.

MANIHOT GLAZIOVII
Mosaic, Deighton, Sudan, 1929, N.
A second mosaic, Kufferath and Ghésquire, Belgian Congo, 1932, N.

MANIHOT ULTISSIMA
Mosaic, Joly, Africa, 1931, N.

MERCURIALES, ANNUA
Mosaic, Verplancke, Belgium, 1932. I.

RICINUS COMMUNIS
Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum.*

GERANACEAE

ERODIUM BOTRYS

Curly top of sugar beet, Severin, California 1934, NI.

ERODIUM CICUTARIUM

Curly top of sugar beet, Carsner, California, 1919, I from sugar beet.

ERODIUM MACROPHYLLUM

Curly top of sugar beet, Severin, California, 1934, N.

ERODIUM MOSCHATUNI

Curly top of sugar beet, Carsner, California, 1919, I, from sugar beet.

GERANIUM sp.

Crinkle mosaic, Pape, Germany, 1932.

GERANIUM CAROLINIANUM

Celery virus 1, Wellman, Florida, 1935, I by *A. gossypii.*

IMPATIENS BALSAMINA

Mosaic, Ocfemia, Philippine Islands, 1924, N.

OXALIS CORNICULATA

Curly top of sugar beet, Severin, California, 1934, I.

OXALIS CORNICULATA ATROPURPUREA

Curly top of sugar beet, Severin, California, 1934, I.

PELARGONIUM sp.

Leaf curl, Fulmek, Germany, 1917, N.
Aucuba mosaic, Blattny, Czechoslovakia, 1933, N.
Interveinal chlorosis, Blattny, Czechoslovakia, 1933, N.

PELARGONIUM HORTORUM

Curly top of sugar beet, Severin & Freitag, California, 1933, NI from sugar beet by *E. tenellus.*
Celery virus 1, Wellman, Florida, 1935, I.

PELARGONIUM ZONALE

Leaf curl, Pape, Germany, 1927, N.
Mosaic, Verplancke, Belgium, 1932.

GESNERIACEAE

DIDYMOCARPUS HORSFIELDII.

GLOXINIA sp.

Aster yellows, Kunkel, N. Y. 1926, I by *C. sexnotata.*

GLOXINIA SPECIOSA
Spotted wilt of tomato. Green, England, 1935.

LECHERIA ROSEA
Virus, Deighton, Sudan, 1932, I.

GRAMINEAE

ACHYRODES AUREUM
Mosaic Elmer, Iowa, 1925, I from *S. officinarum.*

ALOPECUUS FULVUS
Dwarf of rice, Fukushi, Japan, 1933, I by *Nephotettix apicalis* var *cincticeps.*

ANDROPOGON SORGHUM-SUDANSIS
Mosaic, Kunkel, Hawaii, 1924.

ANDROPOGON VIRGATUS
Mosaic, Kunkel, Hawaii, 1924.

AVENA SATIVA
Dwarf of rice, Fukushi, Japan, 1933, I by *N. apicalis* var. *cincticeps.*

BRACHIARIA PLATYPHYLLA
Sugar-cane mosaic, Brandes & Kapphak, U. S. 1923, I from *Saccharum officinarum.*

CHAETOCHLOA LUTESCENS
Sugar-cane mosaic, Brandes, 1919, N. Inoculation by Brandes & Kapphak in 1923.

CHAETOCHLOA MAGNA
Sugar-cane mosaic, Brandes & Kapphak, U. S. 1923, I from *S. officinarum.*

CHAETOCHLOA VERTICILLATA
Sugar-cane mosaic, Kunkel, Hawaii, 1924, N.

COIX LACHRYMA-JOBI
Mosaic, Brandes, Papua.
Clorotic streak, Martin, Hawaii, 1933, N.

CYMBOPOGON CITRATUS
Streak, Storey & McClean, South Africa, 1930, N.

DACTILOCTENIUM ALEGYPTIACEUM
Streak, Storey & McClean, South Africa, 1930, N.

DIGITARIA HORIZONTALIS

Mosaic, Storey, South Africa, 1924, NI, Storey, in a letter to the compiler says that this host is probably the same as the American *Syntherisma sanguinalis*,

Streak, Storey, South Africa, 1924. NI.

DIGITARIA SMUTSII

Streak, Storey, South Africa, 1924, N.

DIGITARIA ERIANTHA

Streak, Storey, South Africa, 1924, N.

DIGITARIA MARGINATA

Streak, Storey, South Africa, 1924, N.

DIGITARIA TERNATA

Streak, Storey, South Africa, 1924, N.

DIPLACHNE ELEUSINE

Streak, Storey, & McClean, South Africa, 1930, N.

ECHINOCHLOA COLONA

Sugar-cane mosaic, Chardon & Veve, Puerto Rico, 1923, I.

ECHINOCHLOA CRUS GALLI

Sugar-cane mosaic. Brandes & Kapphak, 1923 by inoculation from *S. officinarum.*

ECHINOCHLOA CRUS GALLI EDULIS

Dwarf of rice, Shiro, Sangoku & Shiratama, Japan, 1930,I by *N. apicalis* var *cincticeps.*

ELEUSINE INDICA

Sugar-cane mosaic, Chardon & Veve, Puerto Rico, 1931, I by *Aphis maidis.*

Streak, Storey, South Africa, 1925, NI, Mild form.

ERAGROSTI ASPERA

Streak, Storey, South Africa, 1925, N.

ERAGROSTI CILIARIS

Mosaic, Storey, South Africa, 1924.

Streak, Storey, South Africa, 1924.

ERAGROSTIS VALLIDA

Streak, Storey, South Africa, 1928, N.

EUCHLAENA MEXICANA

Celery virus 1, Wellman, Florida, 1934, I.

GYNERIUM SAGITATUM

Sugar-cane mosaic. Abbott, Perú, 1930, N. Also occurs in, Puerto Rico.

HOLCUS HALEPENSIS

Mosaic, Kunkel, Hawaii, 1924.

HOLCUS SORGHUM

Sugar-cane mosaic. Brandes & Kapphak, U. S. 1923, I.

Celerly virus 1, Wellman, Florida, 1934. I.

HORDEUM SATIVUM

Mosaic, McKinney, U. S. 1930, I from Wheat.

HORDEUM SATIVUM vars. HEXASTICHON COELESTI & VULGARE

Dwarf, Shikoku, Japan, 1916, N and Marumi in 1933.

ORYZA SATIVA

Stripe, Hnoshu & Shikoku, Japan, 1917.

Dwarf, Takada, Japan, 1895, N. Known for many years. Said to be first virus disease in which transmission by insects was recognized.

PANICUM BARBINODE

Mosaic, Stahl, Cuba, 1927, N.

PANICUM DICHOTOMIFLORUM

Sugar-cane mosaic, Brandes & Kapphak, U. S. 1923, I from *S. officinarum.*

PANICUM LONGIJUBATUM

Sugar-cane mosaic, Storey, South Africa, 1924, N.

PANICUM MILIACEUM

Dwarf of rice, Wase, Japan, 1930, I, by *N. apicalis* var. *cineticeps.*

PASPALUM BOSCIANUM

Sugar-cane mosaic, Brandes & Kapphak, U. S., 1923, I.

PASPALUM FIMBRIATUM

Sugar-cane mosaic, Walker & Stahl, Cuba, 1926.

PASPALUM SCROBICULATUM

Streak, Storey, South Africa, 1924, N.

PASPALUM VIRGATUM

Sugar-cane mosaic, Walker & Stahl, Cuba, 1926.

PENNISETUM GLAUCUM (-P. TYPHOIDEUM)

Sugar-cane mosaic. Inoculation from *S. officinarum* by Brandes & Kapphak, 1923.

POA PRATENSIS

Dwarf of rice, Fukushi, Japan, 1933, I by *N. apicalis* var. *cincticeps*.

ROTTBOELLIA EXALTATA

Streak, Storey & McClean, South Africa, 1930, N.

SACCHARUM NARENGA

Sugar-cane mosaic, Brandes & Kapphak, U. S. 1923, I.

SACCHARUM OFFICINARUM

Sereh, ? Java, 1882, N.

Sugar-cane, van Musschenbrok, Java, 1890, N. Reported in 1892 by Wilbrink and Ledeboer as gelestrepenzikte (-gold stripe). Inoculation from *Achyrodes aureum* by Elmer in 1925.

Fiji, Lyon, Fiji, 1910, N. Known for many year before reported.

Dwarf, Bell, Australia, 1932, N. Observed first in 1930.

Streak, Storey, 1924, NI. This disease attacks Uba cane which is very resistant to mosaic. First reported by Fuller (1901) who believed it to be due to a soil condition. Wuthrich described this disease as ''yellow stripe'' (1920), but it was not recognized as a virus disease and distinct from mosaic until 1924.

4th disease, Wilbrink, Java, 1929, N was later reported by Martin of Hawaii as ''chlorotic streak.''

Cuban streak, Priode, Cuba, 1933.

SECALE CEREALE

Mosaic, McKinney, U. S. 1930, I from wheat.

Dwarf of rice, Fukushi, Japan, 1933, I by *N. apicalis* var. *cincticeps.*

Celery virus 1, Wellman, Florida, 1934, I.

SETARIA SULCATA

Sugar-cane mosaic, Storey, South Africa, 1929, NI.

SETARIA VERTICILLATA

Streak, Storey McClean, South Africa, 1930.

SORGHUM sp.

Stripe of corn, Briton Jones, Trinidad, 1933, NI. Same as on corn.

SORGHUM ARUNDINACEUM

Transvaal mosaic, Storey, South Africa, 1929, NI. This diseases does not attack sugar-cane. The vector is *A. maidis*.

Streak, Storey & McClean, South Africa, 1930, N.

Sugar-cane mosaic, Storey, South Africa, 1929, N.

SYNTHERISMA PURIENS

Mosaic, Kunkel, Hawaii, 1934.

SYNTHERISMA SANGUINALIS

Sugar-cane mosaic, Chardon & Veve, Puerto Rico, 1923.

SYNTHERISMA VERTICILLARIS

Sugar-cane mosaic, Chardon & Veve, Puerto Rico, 1923.

TRAGUS RACEMOSUS

Streak, Storey, & McClean, South Africa, 1930, N.

TRIPSACUM LAXUM

Sugar-cane mosaic, Kunkel, Hawaii, 1924.

TRITICUM AESTIVUM

Mosaic, Lyman, Illinois, 1919, N. This is the first record. It was supposed to be "take all" but was proved to be a virus diseases about 1923.

Celery virus 1, Wellman, Florida, 1934, I.

TRITICUM COMPACTUM, T. DICOCCUM, T. DURUM, T. MONOCOCCUM, T. POLONICUM, T. SPELTA, T. TURGIDUM and T. VULGARE.

Mosaic, McKinney, U. S. 1930, I from *T. aestivum*.

TRITICUM SATIVUM var. VULGARE

Dwarf, Shikoku, Japan, 1916.

TRITICUM VULGARE

Dwarf of rice, Harukomu, Japan, 1934, I by *N. apicalis* var. *cincticeps*.

UROCHLOA HELOPUS

Sugar-cane mosaic, Storey, South Africa, 1924.

Streak, Storey, South Africa, 1924, N.

ZEA MAYS

Mosaic, Lyon, Hawaii, 1914, N. Proved to be same as sugar-cane mosaic, Kunkel (1927) reported mosaic of corn in Hawaii different from mosaic of sugar-cane and from mosaic of corn

in Southern U. S. He found that *Peregrinus maidis* from North Carolina could not transmit sugar-cane mosaic to corn in the U. S. but that *P. maidis* of Hawaii did transmit the disease. Brandes (1920) reported a mosaic of corn from Puerto Rico which was observed first in 1919. It was transmitted by *A. maidis*. Rosen collected mosaic of corn in Arkansas in 1921. Elmer (1925) reported inoculation from *S. officinarum*.

Streak, Storey, South Africa, 1924, I by *C. mbila*.
Stripe, Stahl, Cuba, 1927, N.
Celery mosaic 1, Wellman, Florida, 1934, I.

ZOYSIA JAPONICA
Stripe, Kuribayashi, Japan 1931, N.

HYDRANGEAE

HYDRANGEA PANICULATA var, GRANDIFLORA
Chlorosis, Clinton, Connecticut, 1919, N.

HYDROPHYLLACEAE

NEMOPHILA sp.
Aster yellows, Kunkel, N. Y. 1926, I from *C. chinensis* and back.

NEMOPHILA MACULATA
Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet by *E. tenellus*.

PHACELIA CAMPANULARIA
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata*.
Tobacco mosaic, Grant, Wisconsin, 1934, I.

PHACELIA CONGESTA
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata*.

PHACELIA GRANDIFLORA
Tobacco mosaic, Grant, Wisconsin, 1934, I.

PHACELIA PARRYI
Tobacco mosaic, Grant, Wisconsin, 1934, I.

PHACELIA RAMOSISSIMA
Curly top of sugar beet, Severin, California, 1934, N.

PHACELIA TENACETIFOLIA
Tobacco mosaic, Grant, Wisconsin, 1934, I.
Celery virus 1, Wellman, Florida, 1934, I.

PHACELIA VISCIDA
Aster yellows, Kunkel, N. Y. 1931, by *C. sexnotata.*

PHACELIA WHITLAVIA
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*
Tobacco mosaic, Grant, Wisconsin, 1934, I.
Celery virus, 1, Wellman, Florida, 1934, I.

IRIDACEAE

CROCUS VERNUS
Mosaic, Fukushi, Japan, 1931, N.

GLADIOLUS sp
Mosaic & dwarf, Dosdall, Minnesota, 1928, I. Observed first in 1925.

GLADIOLUS GRANDAVENSIS
Mosaic, Fukushi, Japan, 1931, I.

IRIS HISPANICA
Mosaic, Atanasoff, Bulgaria, 1928.

IRIS PUMILA
Mosaic, Fukushi, Japan, 1931, N.

IRIS TECTORUM
Mosaic, Fukushi, Japan, 1931, N.

NERINE SARIENSIS
Mosaic, Atanasoff, Bulgaria, 1928.

LABIATAE

AGASTACHE SCROPHULARIAEFOLIA
Mosaic, Gardner, Indiana, 1923, N.

BRUNELLA (PRUNELLA) VULGARIS
Mosaic, Liro, Finland, 1930, N.

DRACOCEPHALUM RUYSCHIANA
Aster yellows, Kunkel, N. Y. 1931, I.

GLECHOMA HEREDRACA
Mosaic, Verplancke, Belgium, 1932, I.

LAMIUM MACULATUM
Mosaic, Verplancke, Belgium, 1932, I.

LAVENDER sp.
Aster yellows, Kunkel, N. Y. 1926. I from *C. chinensis.*

LEONURUS CARDIACA
Mosaic, Gardner, Indiana, 1923, I.

MARRUBIUM VULGARE
Delphinum mosaic, Heald, Washington, 1934, I. Dwarfing.
Delphinium stunt, Burnett, Washington, 1934, I.

MENTHA AQUATICA
Mosaic, Verplancke, Belgium, 1932, I.

NEPETA CATARIA
Mosaic, Elmer, Iowa, 1922, N. Muncie (1922) I from cucurbit mosaic.

PHYSOSTEGIA VIRGINICA
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

PRUNELLA. See BRUNELLA

SALVIA sp.
Spotted wilt of tomato, Gardner, Tompkins & Whipple, California 1934, I.

SALVIA SPLENDENS
Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum.*

Curly top of sugar beet, Freitag & Severin, California, 1933, I, from sugar beet by *E. tenellus.*

SATUREIA HORTENSIS
Aster yellows, Kunkel, N. Y. 1926, I from *C. Chinensis.*

STACHYS SYLVATICA
Mosaic, Verplancke, Belgium, 1932, I.

LAURACEAE

PERSEA PERSEA

Mosaic, No data.

Sun blotch, Parker & Horne, California, 1930, N. Fawcett (1930) reported having seen this disease in Palestine on trees said to have come from California.

LEGMINOSACEAE

ANTHYLLIS VULNERARIA

Mosaic, Merkel, Germany, 1929, N.

ARACHIS HYPOGEA

Mosaic, McClintock, Virginia, 1917, N.

Rosette, Storey & Bottomley, South Africa, 1928, I. In 1926 an anoymous writer expressed the opinion that this was the same as East African "Krauzel-Krankheit" of Zimmermann (1907-1913) and the Java "Krulziekte" of Rutgers (1913). It may be the same as "bunching" and "clumping" of West Africa and India. It may be the same as rosette reported by Bunting (1917) in West Africa. Hayes (1932) reported three types. Sudaranaman (1928) reported a rosette from India similar to that of South Africa. Trochain (1931) reported "leprosy" from Senegal which appears to be the same as rosette.

CANAVALIA GLADIATA

Mosaic, Nelson, Michigan, 1933.

CICER ARIETUM

Curly top of sugar beet, Severin & Henderson, California, 1928. I from sugar beet.

CROTALARIA JUNCEA

Mosaic, Fukushi, Japan, 1927, N.

CROTALARIA STRIATA

Mosaic, Cook, Puerto Rico, 1931, N.

DOLICHUS BIFLORUS

Mosaic, Uppal, India, 1931, N.

DOLICHOS LABLAB

Mosaic, Uppal, India, 1931, N.

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum*.

GLYCINE SOJA

Mosaic, Fukushi, Japan, 1929, N.

LABURNUM sp.

Chlorosis, Baur, Germany, 1907, N.

LABURNUM VULGARE AUREUS

Chlorosis, Baur, Germany, 1907, N.

LABURNUM VULGARE CHRYSOPHYLLUM

Chlorosis, Baur, Germany, 1907, N.

LOTUS AMERICANUS

Curly top of sugar beet, Severin & Henderson, California, 1928, N.

LOTUS STRIGOSUS

Curly top of sugar beet, Severin, California, 1934, N.

LUPINUS sp.

Spotted wilt of tomato, K. M. Smith, England, 1932, I.
Sore-shin, Neill, New Zealand, 1934, N.

LUPINUS ALBUS

Mosaic, Soriano, Argentina, 1932, N.

LUPINUS ANGUSTIFOLIUS

Sore shin, Neill, New Zealand, 1934, N.

LUPINUS PILOSUS

Mosaic, Soriano, Argentina, 1932, N.

MALCONIA MARITIMA

Spotted wilt, K. M. Smith, England, 1932, I.

MEDICAGO ARABICA

Mosaic, Elliott, Arkansas, 1921, I.

MEDICAGO HISPIDA

Curly top of sugar beet, Carsner, California, 1919, N.

MEDICAGO LUPULINA

Mosaic, Dickson, Canada, 1922, I from *T. pratense*.

MEDICAGO SATIVA

Mosaic, Weimer, California, 1931, NI. Had been reported previously but not proved to be a virus.

Curly top of sugar beet, Severin, California, 1928, I by *E. tenellus*.

MELILOTUS, sp.

McLarty, Canada (1920) (suspected). Güssow reports seeing the disease in 1912 and Elliott as seeing it in 1917.

MELILOTUS ALBA

Mosaic, Dickson, Canada, 1922, I from *T. pratense*.

Curly top of sugar beet, Severin & Henderson, California, 1928, I.

MELILOTUS INDICA

Curly top of sugar beet, Carsner, California, 1919, I from sugar beet.

MELILOTUS OFFICINALIS

Mosaic, Dickson, Canada, 1922, from *T. pratense*.

Ring spot of tobacco, Wingard, Virginia, 1928, NI from *N. tabacum*.

NASTURTIUM OFFICINALE

Mosaic, Pinkhof, Czechoslovakia, 1930.

PACHYRHISUS ANGULATUS

Mosaic, Fajardo & Marañon, Philippine Islands, 1932, N.

PACHYRHISUS EROSUS

Mosaic, Fajardo & Marañon, Philippine Islands, 1932, I.

PHASEOLUS ACONITIFOLIUS

Mosaic, Nelson, Michigan, 1932.

PHASEOLUS CUTIFOLIUS var. LATIFOLIUS

Mosaic, Nelson, Michigan, 1932.

PHASEOLUS ANGULARIS

Mosaic, Matsumoto, Japan, 1922, N. (Nelson, Michigan, 1932)).

PHASEOLUS AUREUS

Mosaic, Nelson, Michigan, 1932.

PHASEOLUS CALCARATUS

Mosaic, Nelson, Michigan, 1932.

PHASEOLUS COCCINEUS
Mosaic, Nelson, Michigan, 1932.

PHASEOLUS LIMENSIS
Mosaic, Nelson, Michigan, 1932.

PHASEOLUS LUNATUS
Mosaic, Nelson, Michigan, 1932.
Curly top of sugar beet, Severin. California, 1928, N.
Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum.*

PHASEOLUS MUNGO
Mosaic, Nelson, Michigan, 1932.

PHASEOLUS VULGARIS
Mosaic, N. Y., 1914. N by Stewart & Reddick, 1917, by McClintock, Virginia, 1917. Transmitted from *Melilotus alba, M officinalis, Trifolium repens* and *T. Hybridum* to bean in 1933. Transmitted from *Medicago sativum, Pisum sativum* and *Lathyrus odoratus* by Zaumeyer & Wade. Clinton reported a chlorosis in 1908. Pierce (1934) successfully inoculated with bean virus 1, yellow or bean virus 2 and alfalfa virus 2.
Tobacco mosaic, Price, New York, 1931, I from *N. tabacum.* In 1934 he reported transmission to many varieties.
Tobacco mosaic, Grant, Wisconsin, 1934, I.
Curly top of sugar beet, Carsner, California, 1926, N. Transmitted by inoculation by Severin & Henderson, in 1928.
Ring spot of tobacco, Wingard, Virginia, 1926, I. from *N. tabacum.*
Mosaic, McClintock, Virginia, 1917, I from *A. hypogea.*
Curly top of sugar beet, Severin & Henderson, California, 1928, I.

PHASEOLUS VULGARIS HUMILIS
Mosaic, Nelson, Michigan, 1929.

PISUM SATIVUM
Streak, Linford, Hawaii, 1931. Appears to be same as pineapple yellow spot and disease of *Emilia sagittata.*

PSORALES LITUMINOSA
Mosaic, McKinney, Canary Islands, 1928, N.

SOJA MAX

Mosaic, Clinton, Connecticut, 1915, N. Transmitted from *Cucurbita moschata, Solanum melongena* and *Vigna sinensis,* by Elmer, 1922.

STIZOLOBIUM DEERINGIANUM

Mosaic, Gardner, Indiana, 1923, N.

STROPHASTYLES BELVALA

Mosaic, Gardner, Indiana, 1923, N.

TRIFOLIUM ARVENSIS

Virus disease. Gardner, Indiana, 1927, N.

TRIFOLIUM HYBRIDUM

Curly top of sugar beet, Severin & Henderson, California, 1928, I.

Mosaic, Kawai, Japan, 1931.

TRIFOLIUM INCARNATUM

Mosaic, Canada, 1922, I from *T. pratense.*

Curly top of sugar beet, Severin & Henderson, California, 1928, I.

TRIFOLIUM PRATENSE

Mosaic, Elliott, Arkansas, 1921, N.

Curly top of sugar beet. Severin & Henderson, California, I.

Yellow ring spot, Johnson, Kentucky, 1933, N. Probably same as yellow ring spot of tobacco.

TRIFOLIUM PRATENSE PERENNE

Curly top of sugar beet, Severin & Henderson, California, 1928, I.

TRIFOLIUM REPENS

Curly top of sugar beet, Severin, California, 1928, I.

TRIFOLIUM RESUPINATUM

Virus disease, Gardner, Indiana, 1927, N.

TRIFOLIUM SUBTERRANEUM

Virus disease, Gardner, Indiana, 1927, N.

VICIA ATROPURPUREA

Curly top of sugar beet, Severin, California, 1928, NI.

VICIA FABA

Mosaic, Nelson, Michigan, 1932.

Curly top of sugar beet, Severin & Henderson, California, 1928, NI.
Spotted wilt of tomato, Green, England, 1935.
Celery virus 1, Wellman, Florida, 1934, I.

VICIA SATIVA
Curly top of sugar beet, Severin & Henderson, California, 1928, NI.

VICIA VILLOSA
Curly top of sugar beet, Severin & Henderson, California, 1928, NI.

VIGNA CATJANG
Mosaic, Elmer, Iowa, 1922, I. from *Solanum* sp.

VIGNA SESQUIPEDALIS
Mosaic, Gardner, Indiana, 1925.

VIGNA SINENSIS
Mosaic, Elmer, Iowa, 1924, I From *C. sativus, Soja max* & *Solanum melongena.* (Matsumoto, Japan, 1922).
Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum* and back.
Curly top of sugar beet, Severin & Henderson, California, 1927, NI.

LILIACEAE

ALLIUM sp.
Yellow dwarf, Melhus, Iowa, 1927. This disease is recorded in the earlier literature and is probably the same as reported by Clinton of Connecticut (1906) as brittle.

ALLIUM CEPA
Mosaic, Hori, Japan, 1929, N.
Yellowing or Rotzkrankheit, Müller, Germany, 1930, N.
Virus disease, Blattny, Czechoslovakia, 1931.
Celery virus 1, Wellman, Florida, 1935, I.

ALLIUM FISTULOSUM
Mosaic, Tochinai & Fukushi, Japan, 1931, N.

ALLIUM MOLY
Mosaic, Atanasoff, Bulgaria, 1928.

ALLIUM NEOPOLITANUM
Mosaic, Atanasoff, Bulgaria, 1928.

ALLIUM SATIVUM

Virus disease, Blattny, Czechoslovakia, 1930. Causes a dwarfing and yellowing.

CONVALLARIA MAJALIS

Mosaic, Blattny, Czechoslovakia, 1929, N.

FRITILLARIA CAMTSCHATENSIS.

Fukushi, Japan, 1929. N.

HYACINTHUS sp.

Appears to have been found in U. S. as early as 1919,. The compiler did not find any definite data.

HYACINTHUS ORIENTALIS

Mosaic, Tochinai & Fukushi, Japan, 1931, N.

LILIUM AURANTIUM

Mosaic, Woods, U. S. 1897, N. Cause not known at that time but Gutterman reported mosaic in 1918, Woods reported Bermuda lily disease on *L. harrisii, L. auratium, L. candidum,* all of which were probably the disease now known as mosaic. This disease is supposed to have come from Japan but the first report from that country was by Fukushi, 1929.

Crooked neck, Ogilvie, 1930, N. May be same as mosaic.

Celery virus, 1, Wellman, Florida, 1935, I.

LILIUM CROCEUM

Mosaic, Cotton, England, 1933, N. Mild form.

LILIUM DAURICUM

Mosaic, Fukushi, Japan, 1930, N.

LILIUM FORMOSUM

Mosaic, Ogilvie, 1928, N. He believes that the disease appeared in Bermuda about 1893.

LILIUM GIGANTEUM

Yellow flat, Stout, England, 1930, N.

LILIUM HARRISII (-L. LONGIFLORUM)

Mosaic. The first record of this disease on any of these lilies appears to have been by Stewart of New York, in 1896.

LILIUM HUMBOLTII

Mosaic, Cotton, England, 1933, N. Mild form.

LILIUM LONGIFLORUM

Mosaic, Ogilvie, England, 1927. He said this disease occurred on *L. gigantum, L. formosum, L. harrisii* and on the following varieties *of L. longiflorum*, vis. *tapesuna, insulare* and *eximium*. Reported from Japan by Fukushi in 1929.

Yellow flat, Ogilvie, Bermuda, 1928, N.

Stunt, Pape, Germany, 1934, N.

Celery virus 1, Wellman, Florida, 1935, I.

LILIUM MACULATUM

Mosaic, Fukushi, Japan, 1931, N.

LILIUM MAKINOI

Mosaic, Kawai, Japan, 1931, N.

LILIUM MAXIMOWICZII

Mosaic, Fukushi, Japan, 1929, N.

LILIUM MARTAGON

Dwarfing, Blattny, Czechoslovakia, 1930, N.

LILIUM PHILIPPINENSE var. FORMOSANUM

Mosaic, Fukushi, & Kawai, Japan, 1932, N.

LILIUM PLATYPHYLLUM

Mosaic, Fukushi, Japan, 1931, N.

LILIUM SPECIOSUM var. TAMETOMO

Mosaic, Fukushi, Japan, 1931, N.

LILIUM SUPERBUM

Mosaic, Gutterman, N. Y. 1930, N.

LILIUM TIGRINUM

Mosaic, Fukushi, Japan, 1929, N.

MUSCARI BOTRYOIDES

Atanasoff, Bulgaria, 1928.

Mosaic, Fukushi, Japan, 1931.

MUSCARI COMOSUM & M. C. COMPACTUM

Mosaic, Atanasoff, Bulgaria, 1928.

TULIPA sp.

Mosaic or breaking. The first definite record of this disease appears to be that of Carolus Clusius (Charles de l'Ecluse or l' Escluse) in 1576. There are many later records.

Full breaking, self breaking and clotting, McKenny Hughes, England, 1934. Full breaking is the result of two viruses.

TULIPA GESNERIANA

Mosaic, known throughout Japan.

LIMNANTHACEAE

LIMNANTHES DOUGLASII

Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

LINACEAE

LINUM USITATISSIMUM

Curly top of sugar beet, Severin, California, 1929, I.

LOASACEAE

BLUMENBACHIA HIERONYMI

Aster yellows, Kunkel, N. Y. 1931, I by *E. tenellus.*

CAJOPHORA LATERITIA

Aster yellows, Kunkel, N. Y. 1931, I by *E. tenellus.*

LOBELIACEAE

LOBELIA CARDINALIS

Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet by *E. tenellus.*

LOBELIA ERINUS

Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet by *E. tenellus.*

LYTHRACEAE

LAGERSTROEMIA sp.

Rosette, Brooks, Gambia, 1933, N. May be same as on *A. hypogea.*

MALVACEAE

ALTHAEA OFFINALIS

Variegations, Lindemuth, Germany, 1902. Same as on *Abutilon.*
Infectious chlorosis, Hertsch, Germany, 1927.

ALTHAEA ROSEA

Cotton leaf curl, Kirkpatrick, Sudan, 1931.
Variegations, Lindemuth, Germany, 1902. Same as on *Abutilon.*
Leaf curl, Mason & Lambert, Sudan, 1932, N. Same as on cotton.

Mosaic, Cook, Puerto Rico, 1935, N. First record and first publication.

ABUTILON AVICENNAE

Mosaic, Tropova, U.S.S.R. 1933, N. These plants growing near tobacco developed reticulate mosaic similar to that on tobacco.

ABUTILON DARWINI

Infectious mosaic, Hertsch, Germany, 1927.

ABUTILON HIRTUM

Mosaic, Cook, Puerto Rico, 1931, N. First record.

ABUTILON INDICUM

Infectious chlorosis, Hertsch, Germany, 1927.

ABUTILON MULLERI

Variegations, Kuer, N. Y. 1933.

ABUTILON REGUELII

Variegations, Keur, N. Y. 1933.

ABUTILON SELLOVIANUM

Variegations, Lindemuth, Germany, 1870.
Infectious chlorosis, Hertsch, Germany, 1927.

ABUTILON STRIATUM-THOMPSONII

Mosaic, Introduced into Europe from East Indies and attracted attention in 1868.

ABUTILON THEOPHRASTI

Mosaic, Elmer, Iowa, 1925, N.

ANODA HASTATA

Variegations, Lindemuth, Germany, 1902.

GOSSYPIUM sp.

Brachysum, O. F. Cook, U. S. 1915.
Cyrtosis, O. F. Cook, China & India.
Stenosis, O. F. Cook, Haiti, 1922.
Acromania, O. F. Cook, U. S. 1923.
Tomatosis, O. F. Cook, U. S. 1913.
Hybosis, O. F. Cook, U. S. 1924.

NOTE: None of these diseases by O. F. Cook, have been definitely proven to be due to a virus.

Leaf curl or crinkle, Mason & Lambert, Sudan, 1923–24, N. In

1934, Massey & Andrews reported that it could be transmitted by grafting.

Mosaic, Kulkarni, India, 1924, N.

Virus disease, Afzal, India, 1934, N. Very similar to O. F. Cook's stenosis.

GOSSYPIUM HIRSUTUM

Leaf curl, Jones & Mason, Sudan, 1924, N.

GOSSYPIUM PERUVIANUM

Leaf curl, Farquarson, Nigeria, 1913, N.

GOSSYPIUM VITICOLUM

Leaf curl, Farquarson, Nigeria, 1913, N. This disease is said to attack several weeds in the Sudan.

HIBISCUS CALYCINUS

Mosaic. McKinney, Gold Coast, 1929, N.

HIBISCUS CANNABINUS

Cotton leaf curl, Kirkpatrick, South Africa, 1931, I by *Bemisia fascialis.*

Virus disease? Lotoff, U.S.S.R., 1933.

HIBISCUS ESCULENTUS

Mosaic, Kulkarni India, 1924, N. Park (1929) of Ceylon reported a mosaic in Ceylon attacking 50 per cent of plants. Also attacking *Solanum melongena.*

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum.*

Curly top of sugar beet, Severin, California, 1929, I.

Leaf crinkle, Kirkpatrick, Sudan, 1930, N.

HIBISCUS ROSA-SINENSIS

Virus disease, U. S. 1926, N. No data.

KITAIBELIA VITIFOLIA

Variegation, Lindemuth, Germany, 1902.

LAVATERA ARBOREA

Variegation, Lindemuth, Germany, 1902.

Chlorosis, Hertsch, Germany, 1927.

LAVATERA TRIMESTRIS

Curly top of sugar beet, Freitag, & Severin, California, 1933, I from sugar beet by *E. tenellus.*

MALVA CRISPA
Infectious chlorosis, Hertsch, Germany, 1927.

MALVA BOREALIS
Infectious chlorosis, Hertsch, Germany, 1927.

MALVA MAURITIANA
Variegation, Lindemuth, Germany, 1902.

MALVA PARVIFLORA
Curly top of sugar beet, Carsner, California, 1919. From sugar beet.

MALVA ROTUNDIFOLIA
Curly top of sugar beet, Severin, California, 1929. NI.

MALVA SYLVESTRIS
Mosaic, Verplancke, Belgium, 1932, I.

MALVA VERTICILLATA
Variegation, Lindemuth, Germany, 1902.

MALVASTRUM CAPENSE
Variegation, Lindemuth, Germany, 1902.

MODIOLA CAROLINIANA
Curly top of sugar beet, Severin, California, 1934. N.

PALAVA MALVAEFOLIA
Variegation. Lindemuth, Germany, 1902.

SIDA CARPINIFOLIA
Mosaic, Cook, Puerto Rico, 1931, N.

SIDA NAPAEA
Variegation. Lindemuth, Germany, 1902.
Infectious chlorosis, Hertsch, Germany, 1897.

SIDA NAPAEA RHOMBIFOLIA
Mosaic, Kunkel, Florida, 1930, N.

SIDA SPINOSA
Leaf curl, Mason & Lambert, Sudan, 1932, N. Same as on cotton.

MARTYNIACEAE

MARTYNIA sp.
Aster yellows, Kunkel, N. Y. 1926. from *C. chinensis.*
Spotted wilt of tomato, Gardner & Whipple, California, 1934, I.

MARTYNIA LOUISIANA

Mosaic, Doolittle, Wisconsin, 1921, I from *C. sativus*. Doolittle & Walker, (1923) inoculated from *Asclepias syriaca,* Elmer (1924) from *N. tabacum,* Fernow (1925) from *N. tabacum N. glutinosa,* Kunkel (1926) from *C. chinensis.*

Tobacco mosaic, Grant, Wisconsin, 1934, I.

MORACEAE

FICUS sp.

Mosaic, California, 1933, *N. Ficus palmata* is immune. All others are susceptible. Swingle (1928) reported a mottling on cuttings from Biskra (Algeria). Hodgson (1931) reported mosaic on figs in Tunis.

FLEURY PODOCARPA

Mosaic, McKinney, West Africa, 1929.

HUMULUS sp.

Chlorosis, Salmon & Ware, 1930, N. Known for many years.

Nettlehead, nettly and sprinkly known in England for many years.

Krausel or Kadervast, Blattny, Czechoslovakia, 1930, N. Appears to be distinct from nettlehead.

HUMULUS JAPONICUS

Aster yellows. Kunkel, N. Y. 1931. I by *C. sexnotata.*

Curly top of sugar beet, Freitag & Severin, California, 1933. From sugar beet by *E. tenellus.*

HUMULUS LUPULUS

Mosaic, known in England for many years, Aucuba type, mottle type and hereditary sterility reported in Czechoslovakia by Blattny in 1927.

Chlorosis, Salmon & Ware, England, 1932.

MORUS sp.

Chlorosis, Suzuki, Japan, 1900, N.

Mottling, Cook, Puerto Rico, 1931, N. The writer's attention was called to this disease by Francisco Sein Jr.

MUSACEAE

MUSA sp.

Bunchy top. Goddard, Australia, 1925, N. This disease appears to have been known in Fiji as early as 1885, in Egypt in

1900 and in Australia and Ceylon, in 1913. Stevenson reports that other hosts are *Canna* sp. and *Saccharum officinarum*. A mosaic disease has been reported on banana.

Virus disease, Magee, Australia, 1930, NI. Carried by *Pentalonia nigronervosa.*

MUSA CAVENDISHII

Celery virus 1, Wellman, Florida, 1935, N.

MUSA PARADISICA

Bunchy top, Park, Ceylon, 1930, NI.

MUSA SAPIENTUM

Celery virus 1, Wellman, Florida, 1935, N.

NYCTAGINACEAE

ABRONIA UMBRELLATA var. GRANDIFLORA

Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

BOUGAINVILEA SPECTABILIS

Virus disease, G. H. Martin, Jr., U. S. 1922.

MIRABILIS JALAPA

Curly top of sugar beet, Severin & Freitag, California, 1933, NI. From sugar beet by *E. tenellus.*

ONAGRACEAE

CLARKIA ELEGANS

Aster yellows, Kunkel, N. Y., 1931, I by *C. sexnotata.*

Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet by *E. tenellus.*

FUCHSIA sp.

Spotted wilt of tomato, Holmes Smith, England.

FUCHSIA GRACILIS

Mosaic, McKinney, Canary Islands, 1929, N.

GODETIA GRANDIFLORA

California aster yellows, Severin & Freitag, California, 1934, N.

Mosaic, Verplancke, Belgium, 1932, I.

OENOTHERA BIENNIS

Mosaic, Verplancke, Belgium, 1932, I.

Yellows, Verplancke, Belgium, 1932, I.

PAPAVERACEAE

CHELIDONEUM JANUS

Mosaic, Verplancke, Belgium, 1932, I.

ESCHLOLTZIA CALIFORNICA

Aster yellows, Kunkel, N. Y. 1926, I From *C. chinensis*.

California aster yellows, Severin & Freitag, California, 1934, I.

PAPAVER sp.

Spotted wilt of tomato, Gardner, Tompkins & Whipple, California, 1933, I.

PAPAVER NUDICAULE

Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata*.

Spotted wilt of tomato, Pittman, Australia, 1934, N.

PAPAVER ORIENTALE

Curly top of sugar beet, Freitag & Severin, California, 1933, I.

PAPAYACEAE

CARICA PAPAYA

Curly top or curly leaf, Ciferri, Dominican Republic, 1930, N. Also in Puerto Rico.

PASSIFLORACEAE

PASSIFLORA sp.

Virus disease, Bijl, South Africa, 1931, N.

PASSIFLORA EDULIS

Woodiness or bullet disease, Noble, Australia, 1928. Known for many years.

PEDALIACEAE

SESAMUM RADIATUM

Virus disease, Deighton, Sierra Leona, 1932, N.

PHYTOLACCACEAE

PHYTOLACCA DECANDRA

Mosaic, Woods, U. S., 1902, N.

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum*.

Ring spot of tobacco, Priode, N. Y., 1928, I from *N. tabacum*.

Coarse etch, Johnson, Kentucky, 1930, I. Also attacks several Solanaceae.

Cucumber mosaic (types 1, 2, 3). Johnson, Kentucky, 1930, I. (Also type 3 + veinbanding.)
Healthy potato virus, Johnson, Kentucky, 1930, I.
Celery, virus 1, Wellman, Florida, 1935, I.

PHYTOLACCA RIGIDA
Celery virus 1, Wellman, Florida, 1935, I. Symtomless.

PLANTAGINACEAE

PLANTAGO ALPINA
Aster yellows, Kunkel, N. Y. 1931, I by *E. tenellus.*

PLANTAGO ERECTA
Curly top of sugar beet, Severin, California, 1934, NI.

PLANTAGO FUSCESCENS
Aster yellows, Kunkel, N. Y. 1931, I by *E. tenellus.*

PLANTAGO LANCEOLATA
Mosaic, Kunkel, N. Y. 1928, I. by *C. sexnotata.*

PLANTAGO MAJOR
Aster yellows, Kunkel, N. Y. 1926, I from *C. chinensis,* and back.
California aster yellows, Severin, California 1929, N.
Spotted wilt of tomato, K. M. Smith, England, 1932.
Mosaic, Johnson, Kentucky, 1930. It is not cucumber mosaic.
Yellows, Verplancke, Belgium, 1932, I.
Curly top of sugar beet, Severin, California, 1934, I.

PLANTAGO PSYLLIUM
Aster yellows, Kunkel, N. Y., 1931, I. by *C. sexnotata.*

PLUMBAGINACEAE

ARMERIA ALPINA
Aster yellows, Kunkel, N. Y., 1931, I. by *C. sexnotata.*

LIMONIUM SINUATUM
Curly top of sugar beet, Freitag & Severin, California, 1933, I. From sugar beet, by *E. tenellus.*

POLEMONIACEAE

CABAEA SCANDENS
Curly top of sugar beet, Freitag & Severin, California, 1933. I from sugar beet, by *E. tenellus.*

GILIA CAPITATA
Celery virus 1, Wellman, Florida, 1933, I.

GILIA DENSIFLORA
Aster yellows, Kunkel, N. Y., 1931, I. by *C. sexnotata.*

GILIA TRICOLOR
Aster yellows, Kunkel, N. Y. 1925, I by *C. sexnotata.*

PHLOX DRUMMONDII
Aster yellows, Kunkel, N. Y. 1926, I from *C. chinensis.*
Tobacco mosaic, Grant, Wisconsin, 1934.
Curly top of sugar beet, Freitag, & Severin, California, 1933, I. From sugar beet, by *E. tenellus.*
Celery virus 1, Wellman, Florida, 1935, I. Symptomless.

PHLOX PANICULATA
Aster yellows, Kunkel, N. Y., 1926, I from *C. chinensis.*

POLEMONIUM COERULUM
Aster yellows, Kunkel, N. Y., 1931, I. by *C. sexnotata.*

POLYGONACEAE

FAGOPYRUM ESCULENTUM
Curly top of sugar beet, Carsner, California, 1919, I from sugar beet.
Aster yellows, Kunkel, N. Y. 1926, I from *C. chinensis.*
Celerly virus 1, Wellman, Florida, 1935, I.
Tobacco, mosaic, Grant, Wisconsin, 1934, I.

POLYGONUM AMPHIBIUM HARTWRIGHT
Curly top of sugar beet, Severin, California, 1934, NI.

POLYGONUM AVICULARE
Curly top of sugar beet, Carsner, California, 1919, I.
Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum.*

POLYGONUM LAPATHIFOLIUM
Curly top of sugar beet, Severin, California, 1934, NI.

POLYGONUM MUHLENBERGII
Curly top of sugar beet, Severin, California, 1934, NI.

POLYGONUM PERSICARIA

Mosaic, Verplancke, Belgium, 1932, I.

Yellows, Verplancke, Belgium, 1932, I.

Curly top of sugar beet, Severin, California, 1934, NI.

RHEUM RHAPONTICUM

Mosaic, Dickson, Canada, 1925, N.

Curly top of sugar beet, Severin, California, 1929, I.

RUMEX ACETOSA

Mosaic, Verplancke, Belgium, 1932, I.

Yellows, Verplancke, Belgium, 1932, I.

RUMEX CRISPUS

Curly top of sugar beet, Carsner, California, 1925. Very resistant.

Leaf deforming mosaic, Böning, Germany, 1930, NI. Attacks beets and spinach.

RUMEX LANCEOLATA

Chlorosis, Grainger & Cockerhan, England, 1930, N.

RUMEX OBTUSIFOLIUS

Mosaic, Fernow, N. Y. 1925, N.

Infectious chlorosis, Green, England, 1930, N.

Leaf deforming mosaic, Böning, Germany, 1930.

RUMEX SCUTATUS

Curly top of sugar beet, Severin, California, 1929, I.

PORTULACACEAE

CALANDRINA GRANDIFLORA

Aster yellows, Kunkel, N. Y. 1926. I from *C. chinensis*.

Curly top of sugar beet, Freitag & Severin, California, 1933, I.

PORTULACA sp.

Aster yellows, Kunkel, N. Y. 1926. I from *C. chinensis*.

Curly top of sugar beet, Freitag & Severin, California, 1933, I.

PORTULACA GRANDIFLORA

Curly top of sugar beet, Freitag & Severin, California, 1933, I.

PORTULACA OLERACEA

Curly top of sugar beet, Freitag & Severin, California, 1934, I.

PRIMULACEAE

ANAGALIS ARVENSIS
Curly top of sugar beet, Severin, California, 1934, I.

ANAGALIS LINIFOLIA
Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

PRIMULA sp.
Spotted wilt of tomato, Gardner, Tompkins, and Whipple, California, 1935, I.

PRIMULA DENTICULATA
Mosaic, Fukushi & Kawai. Japan, 1932, N.

PRIMULA ELATOR
Aster yellows, Kunkel, N. Y. 1926. I from *C. chinensis.*

PRIMULA MALACOIDES
Spotted wilt of tomato, Ogilvie, England, 1935.

PRIMULA OBCONIA
Mosaic, Hayashi, Japan, 1928, N.
Virus disease, K. M. Smith, England, 1935, N. Transmitted to *N. glutinosa, N. lansdorphia & D. stramonium.*

PRIMULA POLIANTHA
Curly top of sugar beet, Freitag & Severin, California, 1933, I. From sugar beet by *E. tenellus.*

PRIMULA SAXATALIS
Curly top of sugar beet, Freitag & Severin, California, 1933. I, from sugar beet by *E. tenellus.*

PRIMULA SINENSIS
Virus disease, K. M. Smith, England, 1935, I from *P. obconia.*

PRIMULA VERIS
Curly top of sugar beet, Freitag & Severin, California, 1933, I. From sugar beet, by *E. tenellus.*

RANUNCULACEAE

ADONIS AESTIVALIS
Aster yellows, Kunkel, N. Y., 1931, I. by *C. sexnotata.*

ANEMONE CORONARIA
Curly top of sugar beet, Freitag & Severin, California, 1933, I. From sugar beet, by *E. tenellus.*

ANEMONE NEMEROSA, A. RANUNCULOIDES & A. TRIFOLIA

Alloiophylly, Klebahn, Germany, 1926. N. Contain flagellate bodies which were figured by the author in 1897. This disease resembles those caused by is viruses.

AGUILEGIA CANADENSIS

Mosaic, Elmer, Iowa, 1924, N.

AGUILEGIA COERULEA

Mosaic, Elmer, Iowa, I, from *A. canadensis*.

AGUILEGIA FLABELLATA

Mosaic, Ito, Japan, 1931, N.

AGUILEGIA VULGARIS

Spotted wilt of tomato, Pittman, Australia, 1934, N.

DELPHINUM sp.

Mosaic, Valleau, Kentucky, 1932, N. Also attacks tobacco.
Malformation, Gardner, Indiana, 1927.
Virus disease, Valleau, Kentucky, 1932.
Witches' broom, Hungerford, Idaho, 1933, N. Had been under observation several years.
Dwarf,Heald, Washington, 1934, N.
Stunt, Burnett, Washington, 1934, N.
Spotted wilt of tomato, Gardner, Tompkins, & Whipple, California, 1935, I.

DELPHINUM CONSOLIDA

Tobacco mosaic, Grant, Wisconsin, 1934, I.
Celery virus, 1, Wellman, Florida, 1935, I.

DELPHINIUM NUDICAULE

Curly top of sugar beet, Freitag & Severin, California, 1933, I. From sugar beet, by *E. tenellus*.

NIGELLA DAMSCENA

Curly top of sugar beet, Freitag & Severin, California, 1933, I. From sugar beet, by *E. tenellus*.

PAEONIA sp.

Mosaic, Whetzel, Massachusetts 1915, N.

PAEONIA ALBIFLORA

Infectious chlorosis, Togashi, Japan, 1931.

RANUNCULUS ANEMONE

Spotted wilt of tomato, Pittman, Australia, 1934, N.

RANUNCULUS ASIATICUS

California aster yellows, Severin & Freitag, California, 1934, N.

RESEDACEAE

RESEDA ODORATA

Aster yellows, Kunkel, N. Y. 1926, I from *C. chinensis*.
Curly top of sugar beet, Freitag & Severin, California, 1933, I.

ROSACEAE

FRAGARIA sp.

Blight, Horne, California, 1922, N.
Yellows or xanthosis, Horne, California, 1922, N.
Mosaic, Berkeley, Canada, 1928, N.
Dwarf, Plakidas, Louisiana, 1928, N.
Crinkle, Zeller, & Vaughan, Pacific Coast, 1932.
Yellow edge, Harris, England, 1933, N.
Stunt, Chamberlain, New Zealand, 1934, N.

FRAGARIA COLLINA

Mosaic, Verplancke, Belgium, 1932, 1.
Yellows, Verplancke, Belgium, 1932, I.

HOLODISCUS DISCOLOR

Witches' broom, Zeller, Oregon, 1930, N. Known as early as 1925.

PHYSOCARPUS CAPITATUS

Witches' broom, Zeller, Oregon, 1931, I, by *Aphis spiraeae*.

POTENTILLA MOSPELIENSIS

Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata*.

PRUNUS sp.

Vitrosis, Rietseman, Ukraine, 1930, N, A disease of the cherry plum and peach. In cherry it is associated with mosaic.
Virus disease, Valleau, Kentucky, 1932. Transmitted by budding.

PRUNUS CHICASA

Rosette, E. F. Smith, Georgia, 1891, N.

PRUNUS DOMESTICA

Plum pox, Atanasoff, Bulgaria, 1932, N.

PRUNUS PERSICA

Yellows, U. S. 1791, N. According to E. F. Smith.
Little peach, E. F. Smith, Michigan, 1893, N.

Phony peach, Neal, Georgia, 1920, N. Known for many years, before reported. Hutchins proved that it was transmissible.
Buckskin, Rawlins & Horne, California, 1931, NI.
Mosaic, Hutchins, Texas, 1932, N.
Red suture, Cation, Michigan, 1932, N. Known since, 1911.

PYRUS MALUS
Mosaic, 1924, No data.
Infectious variegations, Bradford & Joley, Michigan, 1933, NI.

ROSA sp.
Streak, Brierley, U. S., 1935, N.

ROSA MANETTI
Chlorosis, Weiss & McWhorter, U. S., 1930, N.
Chlorosis, Nelson, Michigan, 1930, N.

ROSA MULTIFLORA
White in New Jersey and Weiss & McWhorter in Oregon, 1930, NI. The first record was probably made by Norton of Maryland in 1909 but not recognized as a virus disease.

RUBUS sp.
Mosaic, Detmer, Ohio, 1891, N. Appears to be the first record.
Leaf curl, Green, Minnesota, 1895, N. May have been a virus disease.
Yellows, or curl, Melchers, Ohio, 1914, N. May have been a mosaic.
Leaf curl, Zeller, Oregon, 1923, N.
Mosaic, Zeller, Oregon, 1923, N.
Dwarf of Loganbery, Oregon, 1925, N. Also occurs in Washington and California. Mentioned by Darrow in 1918.
Streak, Bennett, Michigan, 1927, N. May be same as reported by Wilcox in Ohio in 1922. Rankin has writen to compiler "Streak as defined by Wilcox (Ohio) 1922 was divided in severe streak and mild streak."
Red raspberry mosaic, Bennett, Michigan, 1927, N. Also attacks blackberry and dewberry.
Mild raspberry mosaic, Michigan, 1927. N. Also attacks, blackberry and dewberry.
Yellow raspberry mosaic, Bennett, Michigan, 1927, N.
Dwarf of blackberry, Zeller, Oregon, 1927, N.
Speckel mosaic, Blattny, Czechoslovakia, 1927, N.
Leaf curl, alpha and beta types, severe streak, mild streak and leaf curl. Rankin, New York, 1931.

Red raspberry mosaic, yellow mosaic, and mild mosaic, Rankin New York, 1931.

Fern leaf, witches' broom & dwarf, Zundel. Pennsylvania, 1931.

Mild streak and severe streak, Cooley, Ohio, 1932, N.

RUBUS OCCIDENTALIS

Mild streak, Cooley, Ohio, 1932, N.

RUBUS LEUCODERMIS

Mosaic, Zeller, Oregon, 1923, N.

RUBUS MACROPETALUS

Mosaic, Zeller, Oregon, 1923, N.

RUBUS PARVIFLORUS

Mosaic, Zeller, Oregon, 1923, N.

RUBUS STRIGOSUS

Mosaic, Bennett, Michigan, 1927.

SORBUS sp.

Chlorosis, Baur, Germany, 1907, N.

SPIRAEA DOUGLASSII, S. PRUNIFOLIA, S. THUNBERGII, and S. VANHOUTEI

Witches' broom, Zeller, Oregon, 1931. Same as on *Holodiscus discolor*. I by *A. spiraea.*

RUBIACEAE

CEPHALANTHUS OCCIDENTALIS

A virus disease, Missouri, 1921, N. No data.

COFFEA sp.

Phloem necrosis, Stahel, Suriname, 1919, N. In 1930 he reported the disease on *C. abeocutae, C. arabica, C. canephora, C. liberica, C. robusta,* and *C. ugandae.*

RUTACEAE

CITRUS sp.

Infectious variegation, Trabut, 1913, N. Atanasoff believes this to be the first record of a virus disease on citrus.

Psorosis, Fawcett, California, 1933, N. Known for many years Atanasoff believes that the blight in Florida (Swingle & Webber, 1896), "mal seco" of Sicilia (Savastano, 1921 and Petri 1931), little leaf, leprosis, decorticosis, brown spot of navel orange, peteca of lemon, endodermis or internal decline of lemon, membraneous stain, crinkle leaf, spot mosaic and ring spot, are all due to viruses.

PTELEA sp.
Chlorosis,Baur, Germany, 1907, N.

SANTALACEAE

SANTALUM ALBUM
Spike disease, McCarthy, India, 1918. First record. Infectious nature demonstrated by Coleman, 1917.

SAPINDACEAE

CARDIOSPERMUM HALICACABUM
Curly top of sugar beet, Freitag & Severin, California, 1933, I. from sugar beet by *E. tenellus*.

DODONAEA VISCOSA
Spike disease, Sastri & Narayana, India, 1931, N. Know for 35 years or more.

SAPOTACEAE

CHRISOPHYLLUM CAINITO
Rosette, Brooks, Gambia, 1932, N. May be same as on *A. hypogea*.

SAXIFRACACEAE

RIBES sp.
Reversion has been known in England for many years. It is now believed to be a virus disease.

RIBES VULGARE
Chlorosis, Clinton, Connecticut, 1920, N.

SCITAMINACEAE see MUSACEAE

SCROPHULARIACEAE

ALONSEA WARSCEWICZI
Aster yellows, Kunkel, N. Y., 1931, I by *C. sexnotata*.

ANTIRRHINUM sp.
Virus disease, Gardner, Indiana, 1923, N.
Spotted wilt of tomato, Holmes Smith, England, 1934, N.

ANTIRRHINUM MAJUS
Ring spot of tobacco, Wingard, Virginia, 1928. I from *N. tabacum*.
Tobacco mosaic, Grant, Wisconsin, 1934, I.
Celery virus 1, Wellman, Florida, 1935, I.

CALCEOLARIA sp.
Aster yellows, Kunkel, N. Y., 1926, I from *C. chinensis*.
Spotted wilt of tomato, Holmes Smith, England, 1934, N.

COLLINSIN BICOLOR
Aster yellows, Kunkel, N. Y., 1931, I by *C. sexnotata*.

CYMBALARIA MURALIS
Curly top of sugar beet, Freitag & Severin, California, 1933. I from sugar beet by *E. tenellus*.

DIGITARIA AMBIGUA
Curly top of sugar beet, Freitag & Severin, California, 1933, I.

DIGITALIS PURPUREA
Tobacco mosaic, Grant, Winconsin, 1934, I.

LINARIA CYMBALARIA
Aster yellows, Kunkel, N. Y., 1931, I by *C. sexnotata*.
Tobacco mosaic, Grant, Winconsin, 1934, I.

LINARIA MAROCCANA
Aster yellows, Kunkel, N. Y., 1931, I by *C. sexnotata*.

MAURANDIA LOPHOSPERMUM
Aster yellows, Kunkel, N. Y., 1931, I by *C. sexnotata*.

MAURANDIA SCANDENS
Aster yellows, Kunkel, N. Y., 1931, I by *C. sexnotata*.

MIMULUS LUTEUS
Aster yellows, Kunkel, N. Y., 1926, I from *C. chinensis*.
Curly top of sugar beet, Freitag & Severin, California, 1933, I.

NEMESIA sp.
Aster yellows, Kunkel, N. Y., 1926, from *C. chinensis*.

NEMESIA STRUMOSA
Curly top of sugar beet. Freitag & Severin, California, 1933.

PENSTEMON sp.
Spotted wilt of tomato, Holmes Smith, England, 1934, N.

PENSTEMON BARBATUS
Tobacco mosaic, Grant, Wisconsin, 1934, I.

SCROPHULARIA MARYLANDICA
Tobacco mosaic, Grant, Wisconsin, 1934, I.

VERBASCUM HYBRIDUM
Aster yellows, Kunkel, N. Y., 1931, I by *C. sexnotata.*

VERBASCUM THAPSUS
Tobacco mosaic, Grant, Wisconsin, 1934, I.

VERNONIA CINEREA
Krug or ''Kroepoek'', Thung, Java, 1934, N.

VERONICA PEREGRINA
Aster yellows, Kunkel, N. Y., 1931, I by *C. sexnotata.*

SOLANACEAE

ATROPA BELLADONA
Spotted wilt of tomato, K. M. Smith, England, 1932, I.

BROWALLIA DEMISSA
Aster yellows, Kunkel, N. Y., 1931, I by *C. sexnotata.*

BROWALLIA SPECIOSA
Curly top of sugar beet, Freitag & Severin, California, 1933 I from sugar beet, by *E. tenellus.*

CAPSICUM sp.
Mosaic, Allard, D. C., 1912, I, transmitted from *C. sativus* by Doolittle (1920) from *Physalis longifolia,* by Gardner (1921), from tobacco by E. M. Johnson, 1930.
Virus disease, Blodgett, N. Y., 1927, I from apparently healthy potato.
Spotted wilt of tomato, K. M. Smith, England, 1932, I.

CAPSICUM ANNUUM
Mosaic, Transmitted from *C. sativus* by Doolittle (1920) and from *Asclepias syriaca* and back by Doolittle & Walker (1923). E. M. Johnson (1930) reported inoculation with 7 strains.
Mosaic, Blodgett, N. Y. 1927, I from apparently healthy potato.
Healthy potato virus + veinbanding, Johnson, Kentucky, 1930.
Potato mosaic, J. Henderson Smith, England, 1928, I from *L. esculentum.*
Etch, etch +, and severe etch, Johnson, Kentucky, 1930.
Veinbanding, Johnson, Kentucky, 1930, I.
Cucumber mosaic (3 types) Johnson, Kentucky, 1930, Also type 3, and veinbanding virus.
Green & White tobacco mosaic, Johnson, Kentucky, 1930, N.
Leaf roll, Dykstra, U. S., 1930, I from potato.

Celery mosaic, Doolittle, Florida, 1931, N. Appears to be same as cucumber mosaic.

Spotted wilt of tomato, K. M. Smith, England, 1932, I.

Necrosis, van der Meer, Holland, 1932, I from apparently healthy potato.

Glass house streak, Ainsworth, England, 1933.

Celery virus 1, Wellman, Florida, 1934, I.

CAPSICUM ANNUUM var, GROSSUM

Mosaic, McKinney, Liberia & French Camaroon, 1929, N.

CAPSICUM FRUTESCENS

Curly top of sugar beet, Severin, California, 1929, NI.

Tobacco mosaic, Holmes, New York, 1932, I, from *N. tabacum.*

Celery virus 1, Wellman, Florida, 1935, I.

CYPHOMANDRA BETACEA

Mosaic, Fukushi, Japan, 1929, N.

DATURA sp.

Spotted wilt, Gardner & Whipple, California, 1934, I.

DATURA METELOIDES

Mosaic, Fernow, N. Y., 1925, I from *S. tuberosum, D. stramonium* and *N. glutinosum.*

Celery virus 1, Wellman, Florida, 1935, I, Symptomless.

DATURA STRAMONIUM

Allard, D. C. 1912, Inoculated from *N. tabacum; A. graveolens* and *N. glutinosum* by Elmer, 1925; from *N. tabacum, L. esculentum, N. physalodes, N. glutinosa, S. aculeatissimum, S. atropupureum, S. tuberosum* and *D. stramonium.*

Curly top of sugar beet, Severin, California, 1929, I.

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum.*

Potato mosaic, J. Henderson Smith, England, 1928, I from *L. esculentum.*

Tobacco mosaic (6 strains), Johnson, Kentucky, 1930, I.

Etch, etch +, and severe etch, Johnson, Kentucky, 1930, I.

Veinbanding, Johnson, Kentucky, 1930, I. No symptoms.

Healthy potato mosaic, Johnson, Kentucky, 1930, I.

Cucumber mosaic, (3 types), Johnson, Kentucky, 1930, I. Also type 3 and veinbanding virus.

Crinkle A of potato, Salaman, England, 1930, I from *S. tuberosum.*

Leaf roll, Dykstra, U. S. 1930, I, from potato.
Spotted wilt of tomato, K. M. Smith, England, 1931, I.
Krausel mosaic, Schaffnit & Müller, Germany, 1931, I from *S. tuberosum.*
Streak necrosis of potato, Schaffnit & Müller, Germany, 1931, I.
Mosaic, van der Meer, Holland, 1932, I from apparently healthy potato.
Aucuba or yellow mosaic, Caldwell, England, 1932, N.
Hy III, Hamilton, England, 1932, I.
Necrotic virus diseases, Schultz & Raleigh, Maine, 1933, I from *S. tuberosum.*
Necrotic lesions from tobacco mosaic, Holmes, New York, 1932.
Obscure virus disease, Moore, South Africa, 1932. May be same as spotted wilt of tomato. Also attacks *N. tabacum,* two species of *Physalis* and *Nicandra physaloides.*
Spotted wilt of tomato, Ainsworth, England, 1933, I.
Glass house streak, Ainsworth, England, 1933.
Kromnek or Kat River disease, Moore, South Africa, 1933.
Yellow mottle mosaic, (virus 1.) Ainsworth, England, 1934, from *C. sativus.*
Foliar necrosis (virus D), Bawden, England, 1934, I from *S. tuberosum.*
Celery virus 1, Wellman, Florida, 1934, I, Symptomless.
Spotted wilt of tomato, Gardner, & Whipple, California, 1934, N.
Virus disease, K. M. Smith, England, 1935, I from *Primula obconica.*

DATURA TATULA

Mosaic, Allard, D. C. 1914, I, from *N. tabacum.*
Leaf roll, Dykstra, U. S. 1930, I from potato.
Mosaic, Verplancke, Belgium, 1932, I.
Yellows, Verplancke, Belgium, 1932, I.

DATURA QUERCIFOLIA

Yellows, (or mosaic) Allard, D. C. 1914, I from *N. tabacum.*

HYOSCYAMUS NIGER

Yellows, (or mosaic) Allard, D. C. 1914, I from *N. tabacum.*
Potato mosaic, J. Henderson Smith, England, 1928, I from *L. esculentum.*
Aster yellows, Kunkel, N. Y., 1931, I by *C. sexnotata.*
Tomato mosaic, Schaffnit & Müller, Germany, 1931, I from *L. esculentum.*

Krausel mosaic, Schaffnit & Müller, Germany, 1931, I from *S. tuberosum.*

Streak of potato, Schaffnit & Müller, Germany, 1931, I.

Streak necrosis of potato, Schaffnit & Müller, Germany, 1931, I from *S. tuberosum.*

Mosaic, van der Meer, Holland, 1932, I from apparently healthy potato.

Spotted wilt of tomato, K. M. Smith, England, 1932, I.

Hy I, II, II, and IV, Hamilton, England, 1932.

LYCOPERSICON ESCULENTUM

Winter blight or tomato streak, Bailey, N. Y. 1892, N. Also reported by Lodeman in 1892, and by Selby in 1896. The first description was by Bailey. Dickson (1925) found that this disease was caused by a mixture of tobacco and potato mosaic viruses.

Mosaic, Sturgis, Connecticut 1899, N. Same as tobacco mosaic. Also by Woods in 1902). (Filiform fern leaf and cut leaf are other forms of mosaic.)

Mosaic transmitted from *Physalis longifolia* by Gardner (1921), from *P. subglabrata, P. virginiana, P. heterophylla* and *S. carolinensis* by Gardner (1922); from *Abutilon theoprasti, Zinnia elegans, Calendula officinalis, Asclepias syrica, Nepeta cataria, Cucumus sativus, Martynia louisiana Zinnia elegans* and *Apium graveolens* by Elmer (1922); from *Phaseolus vulgaris, Cucubita pepo, Stokesia laevis* and *Nicotiana glutinosa, N. tabacum* by Elmer (1925); from *N. tabacum, N. nigrum* and *S. tuberosum* by Fernow (1926). E. M. Johnson (1930) recorded 7 types.

Mosaic, Hori, Japan, 1920. N.

Cucumber mosaic, Johnson, Wisconsin, 1926, I from *C. sativus.*

Petunia mosaic, Johnson, Wisconsin, 1926, I from *N. tabacum.*

Speckeled tobacco mosaic, Johnson, Wisconsin, 1926, I from *N. tabacum.*

Mild tobacco mosaic, Johnson, Wisconsin, 1926, I from *N. tabacum.*

Yellows, Western yellows, yellow blight, & Summer blight, McKay & Dykstra, California, 1926, N. The first record appears to be in the Idaho Annual Report in 1904. Proved to be same as curly top of sugar beet.

Curly top of sugar beet, Severin, California, 1928, NI.

Spotted wilt of tomato, Simmons, Australia, 1927. Reported from Wisconsin by Doolittle in 1931.

Yellow mosaic, Fukushi, Japan, 1928. N.

Potato mosaic, J. Henderson Smith, England, 1928, I.

Witches' broom, Young and Morris, Montana, 1928, I. Attacks potato and tobacco.

Etch, etch +, severe etch, Johnson, Kentucky, 1930, N.

Mosaic, from apparently healthy potato, Johnson, Kentucky, 1930, NI.

Veinbanding, Johnson, Kentucky, 1930.

Ring mosaic, Johnson, Kentucky, 1930, N.

Cucumber mosaic (3 types) Johnson, Kentucky, 1930, I.

Spotted wilt of tomato, Samuel, Bald & Pittman, Australia, 1930, N.

Aster yellows, Kunkel, Maryland, 1930, I.

Leaf roll, Dykstra, U. S. 1930, I from potato.

Krausel mosaic, Schaffnit & Müller Germany, 1931, I from *S. tuberosum.*

Streak of potato, Schaffnit & Müller, Germany, 1931, I from *S. tuberosum.*

Spotted wilt of tomato, K. M. Smith, England, 1931.

Bunchy top, McClean, South Africa, 1931. Also attacks *Physalis peruviana.*

Streak necrosis of potato, Schaffnit & Müller, Germany, 1931, I, from *S. tuberosum.*

Streak, Valleau, Kentucky, 1932. By inoculation with tobacco mosaic, three strains of tobacco mosaic and plus healthy-potato virus, three strains of cucumber virus and healthy-potato virus, cucumber virus and etch + virus, and by healthy potato virus plus veinbanding virus.

Aucuba or yellow mosaic, Caldwell, England, 1932, N.

Leaf curl, Afzal, India, 1932 N. Same as on cotton.

"Kroepoek", Thung, Java, 1932, I. from *N. tabacum.*

Mosaic, van der Meer, Holland, 1932, from apparently healthy potato.

Hy III, Hamilton, England, 1932, I.

Die back, Shapovalov, California, 1933, N.

Woody fruit, Rischkow, Karatschewsky & Michailowa, Crimea, 1933, N. Appear to be same as big bud of Australia, local name is "Stolbur".

Stripe or streak, Ainsworth, England, 1933, N. Attacks, *N. tabacum, N. macrophylla, D. stramonium, S. melongena, S.*

ciliatum, P. pubescens, C. annuum, Petunia sp., and *sativus*. Caused by a mixture of tomato and potato viruses.

Mild mosaic, Ainsworth, England, 1933, N. Same as Johnson's tobacco mosaic No. 1.

Glass house streak, Ainsworth, England, 1933. Attacks *N. glutinosa, D. stramonium, P. pubescens* and *C. annuum*. Caused by a single virus.

Kromnek or Kat River Disease, Moore, South Africa, 1933. Also on tobacco and other Solanaceae. First record by Lounsburg in 1906.

Foliar Necrosis (Virus D), Bawden, England, 1934.

Celery virus 1, Wellman, Florida, 1934, I.

Mosaic, Aisworth, England, 1934, I. Caused by virulent viruses of potato. Same as potato virus X.

Narrow leaf, Chamberlain, New Zealand, 1934, N. Very similar to filiform leaf.

Delphinium dwarf, Heald, Washington, 1934, I.

Delphinum stunt, Burnett, Washington, 1934, I.

4 streaks, Ainsworth, Berkeley & Caldwell, England, 1934, described four streaks; (I) single streak virus attacking tomato, tobacco, *D. stramonium* and *N. glutinosa*; (II) mixed-virus streak attacking tomato, *N. glutinosa* and *D. stramonium*; (III) stem necrosis streak of tomato and (IV) ring mosaic streak of tomato.

Yellow mottle mosaic, Ainsworth, England, 1935, I. from *C. sativus*.

Spotted wilt of tomato, Ogilvie, England, 1935, N.

LYCOPERSICON PIMPINELLIFOLIUM

Tobacco mosaic, Holmes, New York, 1932, I.

Virus disease, Hoggan & Johnson, Wisconsin, 1935, I. From *Brassica* sp.

NICANDRA sp.

Spotted wilt of tomato, Gardner & Whipple, California, 1934.

NICANDRA PHYSALOIDES

Mosaic, Gardner, Indiana, 1921, I from *L. esculentum; N. tabacum, S. aculeatissimum; D. stramonium, N. glutinosa, S. tuberosum, N. rustica* and *Echinocystis lobata*. E. M. Johnson (1930) inoculated with 7 strains.

Potato mosaic, J. Henderson Smith, England, 1928, I. from *L. esculentum*.

Ring spot of tobacco, Wingard, Virginia, 1928, I, from *N. tabacum.*

Etch, etch, +, severe etch and coarse etch, Johnson, Kentucky, 1930, I.

Cucumber mosaic (3 types), Johnson, Kentucky, 1930, I. Also type 1 + veinbanding.

Tomato mosaic, Schaffnit & Müller, Germany, 1931, I, from *L. esculentum.*

Krausel mosaic, Schaffnit & Müller, Germany, 1931, from *S. tuberosum.*

Streak of potato, Schaffnit & Müller, Germany, 1931, I from *S. tuberosum.*

Streak necrosis of tobacco, Schaffnit & Müller, Germany, 1931, I from *S. tuberosum.*

Virus disease, Moore, South Africa, 1. May be same as spotted wilt of tomato.

Obscure virus disease, Moore, South Africa, 1932. Also attacks *D. stramonium* and two species of *Physalis* and *N. tabacum.*

Kromnek or Kat River Disease, Moore, South Africa, 1933.

Delphinium mosaic, Heald, Washington, 1934.

Delphinium stunt, Burnett, Washington, 1934, I.

NICOTIANA ACCUMINATA

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum.*

Aucuba or yellow mosaic, Kunkel, N. Y. 1932, I.

Tobacco mosaic, Holmes, N. Y. 1932, I.

Spotted wilt of tomato, Gardner & Whipple, California, 1934, I.

NICOTIANA AFFINIS

Potato mosaic, J. Henderson, Smith, England, 1928, I from *L. esculentum.*

NICOTIANA ALATA

Mosaic, Allard, D. C. 1914, I. Inoculated from *Phaseolus vulgaris,* by Elmer, 1925.

Aucuba or yellow mosaic, Kunkel, N. Y. 1932.

Curly top of sugar beet, Freitag & Severin, California, 1933, I.

Spotted wilt of tomato, Gardner & Walker, California, 1934.

Virus disease, K. M. Smith, England, 1935. I from *Primula obconia.*

NICOTINA CLEVELANDI

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tobacum.*

NICOTIANA GLAUCA

Mosaic, Allard, D. C. 1917, I from *N. tabacum.* Very resistant.

Green mosaic with trace of yellow, McKinney, D. C. 1931.

Spotted wilt of tomato, K. M. Smith, England, 1932, I.

Crinkel or ''Kroepoek'', Thung, Java, 1932.

Curly top of sugar beet, Freitag & Severin, California, 1934, I.

NICOTIANA GLUTINOSA

Mosaic, Allard, D. C. 1916. Was believed to be distinct from mosaic of tobacco but Walker (1926) demonstrated that it was the same. From *N. tabacum* and *D. stramonium* by Elmer (1925), from *P. decandra* by Walker (1924), from *L. esculentum, S: aculeatissimum, N. glutinosa, N. physaloides* and alfalfa, by Pierce (1934).

Ring spot of tobacco, Fromme, Wingard & Priode, Virginia, 1928, I from *N. tabacum.*

Aucuba or yellow mosaic, Kunkel, N. Y. 1932, I, and by Caldwell in England same year, N.

Spotted wilt of tomato, K. M. Smith, England, 1932, I.

Tobacco mosaic, Holmes, N. Y. 1932, I from *N. tabacum.*

Hy III, Hamilton, England, 1932, I.

Glass house streak, Ainsworth, England, 1934.

Yellow mosaic, Ainsworth, Berkeley & Caldwell, England, 1934.

Foliar mosaic (Virus D), Bawden, England, 1934.

Celery virus 1, Wellman, Florida, 1934, I.

Virus diseases, K. M. Smith, England, 1935, I, from *Primula obconia.*

Yellow mottle mosaic (virus 1). Ainsworth, England, 1935, I, from *C. sativus.*

Virus disease, Hoggan & Johnson, Wisconsin, 1935, I from *Primula obconia.*

Yellow mottle mosaic (virus 1). Ainsworth, England, 1935, I, from *C. sativus.*

Virus disease, Hoggan & Johnson, Wisconsin, 1935, I from *Brassica.*

NICOTIANA LANCEOLATA

Mosaic, Cruz & Bruner, Cuba, 1931, N.

NICOTIANA LANSDORFII

Mosaic, Allard, D. C. 1914, I very resistant.

Ring spot of tobacco, Fromme, Wingard, Virginia, 1928, I from *N. tabacum.*

Aucuba or yellow mosaic, Kunkel, N. Y. 1932.

Spotted wilt of tomato, Gardner, Tompkins & Whipple, California, 1934, I.

Virus disease, K. M. Smith, England, 1935, I from *Primula obconia.*

NICOTIANA LONGIFLORA

Mosaic, Allard, D. C. 1914, I.

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum.*

NICOTIANA MACROPHILLA

Stripe and curl, Böning, Germany, 1931, N.

Spotted wilt of tomato, Ainsworth, England, 1933, I.

NICOTIANA MULTIVALIS

Ring spot, Wingard, Virginia, 1928, I.

NICOTIANA PANICULATA

Mosaic, Allard, D. C. 1914, I.

Ring spot of tobacco, Wingard, 1928, from *N. tabacum.*

Aucuba or yellow mosaic, Kunkel, U. S. 1932. I.

NICOTIANA PLUMBAGINIFOLII

Mosaic, Allard, D. C., 1914.

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum.*

NICOTIANA QUADRIVALIS

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum.* Also the var *multivalis.*

Tobacco mosaic, Holmes, N. Y. 1932, I from *N. tabaccum.*

NICOTIANA REPANDA

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum.*

NICOTIANA RUSBYI

Aucuba or yellow mosaic, Kunkel, N. Y. 1932, I.

NICOTIANA RUSTICA

Mosaic, Allard, D. C. 1914, I. From tobacco in 1930; from *N.*

Cucumber mosaic, Johnson, Wisconsin, 1926, I from *C. sativus*. Valleau & Johnson by inoculation from *N. tabacum*, melons and *Asclepias* sp. 1928. Hoggan reported inoculations with ordinary and yellow cucumber mosaics in 1935. Ainsworth of England reported inoculation with yellow mosaic (virus 1) from cucumber in 1935.

Petunia mosaic, Johnson, Wisconsin, 1926, I.

Mild tobacco mosaic, Johnson, Wisconsin, 1926, I.

Streak, Johnson, Wisconsin, 1926, I. From *S. tuberosum* and *N. tabacum*.

3 types of tobacco mosaic, Johnson, Wisconsin, 1926, I from apparently healthy potatoes.

Rotterdam B disease, Jochems, Sumatra, 1926.

Vein disease, Jochems, Sumatra, 1926.

Etch, etch +, severe etch, coarse etch, Johnson, Kentucky, 1932, N.

Potato mosaic, J. Henderson Smith, England, I from *L. esculentum*.

Ringspot of tomato, Johnson and Valleau of Kentucky, 1928, NI from *N tabacum, C. sativus,* and *S. carolinensis*.

Witches' broom, Young, Montana, 1929. Also attacks *S. tuberosum* and *L. esculentum*.

Yellow mosaic, Fukushi, Japan, 1929.

Curly top of sugar beet, Severin, California, 1929.

Spotted wilt of tomato, K. M. Smith, England, 1930 and Samuel, Bald & Pittman, Australia who inoculated from *L. esculentum*.

Veinbanding, Valleau, Kentucky, 1930. In fields where potatoes had been grown. Also by Johnson.

Spotted necrosis, Valleau, Kentucky, 1930, I from potato. Same as rugose mosaic of potato, caused by mixture veinbanding and healthy potato viruses.

Crinkle A of potato, Salaman, England, 1930, I, from *S. tuberosum*.

Veinbanding, Johnson, Kentucky, 1930, N.

Healthy potato virus, Johnson, Kentucky, 1930, I.

Cucumber mosaic, (3 types), Johnson, Kentucky, 1930, N.

Virus disease, Moore, South Africa, 1930, I. Appears to be same as local virus disease of tomato, which may be the same as spotted wilt of tomato of Australia. Same as a virus disease of *D. stramonium, Physalis, Nicandra physaloides*.

Streak necrosis of potato, Schaffnit & Müller, Germany, 1931, I from *S. tuberosum*.

Streak of potato, Schaffnit & Müller, Germany, 1931, I.

Green ring spot, Valleau & Johnson, Kentucky, 1931, N. Can be transmitted by seeds.

Celerly mosaic, Doolittle, Florida, 1931, I. Probably same as cucumber mosaic.

Green mosaic, free from yellow, McKinney, D. C. 1931, Mild.

Spot necrosis, Koch, Wisconsin, 1931, N. Same as rugose mosaic of potato. Caused by combination of two distinct viruses.

"Kroepoek," Kerling, Java, 1932, N. Also attack *Zinnia elegans*. Thung reports three types: (1) Common, (2) transparent and curl disease or "Krulziekte". Has been transmitted to tomato, *N. glauca* and *N. rustica*. A similar disease occurs on *Synedrella nodiflora* and *Zinnia elegans*.

Leaf curl of cotton, Afzal, India, 1932, N.

Ring spots (green and yellow), Valleau, Kentucky, 1932, N.

Hy I and II, Hamilton, England, 1932, NI.

Leaf curl, crinkle, frenching and crinkle dwarf. Storey, South Africa, 1932, N. Also known as cabbaging in Nyasaland and "Kroepoek" in Java.

Spotted wilt of tomato, K. M. Smith, England, 1932, I.

Aucuba mosaic, Kunkel, N. Y. 1932. I.

Kromnek or Kat River Disease, Moore, South Africa, 1933. Also on tomato and other solanaceae. First record by Lounsburg 1906.

An obscure and destructive disease, Moore, South Africa, 1932, N. Also attacks *Datura stramonium, Nicandra physaloides* and two species of *physalia.*

Delphinium virus, Valleau, Kentucky, 1932.

Delphinium stunt, Burnett, Washington, 1934, I from *Delphinium*.

Delphinium dwarf, Heald, Washington, 1934, I.

Mosaic, Pierce, Wisconsin, 1934, I from alfalfa.

Yellow mosaic of tomato, Ainsworth, Berkeley and Caldwell, England, 1934.

Foliar necrosis (virus D), Bawden, England, 1934, I from *S. tuberosum*.

Streak, Dufrenoy, France, 1934, I from Peony.

Celery virus 1, Wellman, Florida, 1934, I.

Delphinium virosis, Burnett, Washington, 1934, I.

Virus disease, Hoggan & Johnson, Wisconsin, 1935, I from *Brassica* sp.

Virus disease, K. M. Smith, England, 1935, I from *Brassica* sp. and *Primula obconia.*

NICOTIANA TOMENTOSA

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum.*

Mosaic, Holmes, N. Y., 1932, I from *N. tabacum.*

NICOTIANA TRIGONOPHYLLA

Ring spot of tobacco, Wingard, 1928, I from *N. tabacum.*

NICOTIANA VISCOSUM

Mosaic, Allard, D. C., 1916, Walker (1925) stated that this was *N. glutinosa.*

"Krömenk," Lounsburg, South Africa, 1906, N.

"Corcova," Fawcett, Argentine, 1921.

PETUNIA sp.

Mosaic, Woods, D. C. 1902, N. Allard inoculated from *N. tabacum* in 1912 and Elmer from squash in 1922.

Spotted wilt of tomato, K. M. Smith, England, 1932, I.

Rosette, Brooks, Gambia, 1932, N. Appears to be same as on *A. hypogea.*

Hy III, Hamilton, England, 1932, I.

PETUNIA HYBRIDA

Curly top of sugar beet, Severin & Freitag, California, 1933, NI.

Ring spot of tobacco, Priode, N. Y., 1928, I.

Mild mosaic of tobacco (type 1). Johnson, Kentucky, 1930, N.

Etch, etch +, severe etch, coarse etch, Johnson, Kentucky, 1930, N.

Cucumber mosaic (type 1), Johnson, Kentucky, 1930, N.

Veinbanding of tobacco, Johnson, Kentucky, 1930, N.

Healthy potato virus, Johnson, Kentucky, 1930, N.

Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata.*

Curly top of sugar beet, Severin & Freitag, California, 1933, NI. From sugar beet by *E. tenellus.*

Delphium stunt, Burnett, Washington, 1934, I.

Delphium mosaic, Heald, Washington, 1934, I.

Celery virus 1, Wellman, Florida, 1935, I.

PETUNIA VIOLACEA

Mosaic, Elmer, Iowa, 1925, I from *Cucumis sativus.*

Spotted wilt of tomato, K. M. Smith, England, 1925, I from *C. sativus* and *C. pepo.* The former a symptomless carrier.

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum.*

Potato mosaic, J. Henderson, Smith, England, 1928, I from *L. esculentum.*

Mosaic, Fukushi, Japan, 1927.

Yellow mosaic, Kawai, Japan, 1932.

PHYSALIS sp.

Mosaic, Allard, D. C. 1912, I from *N. tabacum.* Inoculated from *C. sativus,* by Doolittle and Walker in 1923.

Celery mosaic, Doolittle, Florida, 1931. Probably same as cucumber mosaic.

Virus disease, Moore, South Africa, 1932, I. May be same as spotted wilt of tomato.

Rugose mosaic, Dykstra, U. S. 1931, I from *S. tuberosum.*

An obscure virus disease, Moore, South Africa, 1932. Attacks *D. stramonium.*

Spotted wilt of tomato, Tompkins & Gardner, 1934, I.

PHYSALIS ALKENGI

Mosaic, Nishimura, U. S., 1918, I. From tobacco. No symptoms. Holmes (1932) said that this species showed symptoms for a short time.

Mild mosaic, van der Meer, Holland, 1932, I from apparently healthy potatoes.

Celerly virus 1, Wellman, Florida, 1935, I.

PHYSALIS ANGULATA

Ring spot of tobacco, Wingard, Virginia, 1928, I from *N. tabacum.*

Mosaic, Holmes, N. Y. 1932, I from *N. tabacum.*

Celerly virus 1, Wellman, Florida, 1934, I.

PHYSALIS HETEROPHYLLA

Mosaic, Gardner & Kendrick, Indiana, 1922, NI from *L. esculentum.* From *R. obtusifolius, N. tabacum* by Fernow in 1925. From *C. sativus* by Walker in 1926. From tobacco by E. M. Johnson (1930).

Tobacco mosaic, (7 strains) Johnson, Kentucky, 1930, I.

Etch, etch +, severe etch and coarse etch, Johnson, Kentucky, 1930, NI.

Veinbanding, Johnson, Kentucky, 1930, I.

Healthy potato virus, Johnson, Kentucky, 1931, N.

Cucumber mosaic, (3 types), Johnson, Kentucky, 1930, I. Also type 3 veimbanding virus.

Ring spot of tobacco, Johnson, Kentucky, 1930, I.

PHYSALIS LOGASCAE

Celerly virus 1, Wellman, Florida, 1934, I.

Mosaic, Doolittle & Walker, 1934, I from *Commelina nudiflora.*

PHYSALIS LONGIFOLIA

Mosaic, Gardner, Indiana, 1921, NI, from *L. esculentum.*

PHYSALIS MINIMA

Kromnek or Kat River Disease, Moore, South Africa, 1932.

PHYSALIS PERUVIANA

Mosaic, Gardner & Kendrick, Indiana, 1922, I from *L. esculentum.*

Tobacco mosaic, Holmes, N. Y., 1932, from *N. tabacum.*

Celery virus 1, Wellman, Florida, 1935, I.

PHYSALIS PUBESCENS

Mosaic, Gardner & Kendrick, Indiana, 1922, I, from *L. esculentum.* Transmitted by Walker from *C. sativus* (1924) and from *Phytolacca decandra, N. tabacum* and *L. esculentum* (1925). By Gardner & Kendrick, from *P. subglabrata* and *P. heterophylla* (1925). From tobacco, E. M. Johnson (1934).

Mosaic, Fukushi, Japan, 1928.

Tobacco mosaic, Johnson, Kentucky, 1930, N.

Etch, etch +, severe etch and coarse etch, Johnson, Kentucky, 1930, I.

Veinbanding, Johnson, Kentucky, 1930, I.

Healthy potato mosaic, Johnson, Kentucky, 1930, I.

Glass house streak, Ainsworth, England, 1933.

Celery virus 1, Wellman, Florida, 1934, I.

PHYSALIS SUGLABRATA

Mosaic, Gardner & Kendrick, Indiana, 1922, N. Transmitted from *L. esculentum, N. tabacum, S. tuberosum* and *R. obtusifolius* by Fernow (1925) and from *C. sativus* by Walker (1926).

PHYSALIS VIRGINIANA

Mosaic (tomato), Gardner & Kendrick, Indiana, 1922, N.

PHYSALIS WRIGHTII

Curly top of sugar beet, Severin, California, 1934, NI.

SALPIGLOSSIS sp.

Aster yellows, Kunkel, N. Y. 1926, I from *C. chinensis.*

Spotted wilt of tomato, Gardner & Whipple, California, 1935, I.

SALPIGLOSSIS SINULATA

Potato mosaic, J. Henderson Smith, England, 1928, I from *L. esculentum.*

Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet, by *E. tenellus.*

SCHIZANTHUS sp.

Aster yellows, Kunkel, N. Y. 1926, I from *C. chinensis.*

Spotted wilt of tomato, Ogilvie, England, 1933, N.

SCHIZANTHUS WISETONENSIS

Curly top of sugar beet, Freitag & Severin, California, 1933, I from sugar beet by *E. tenellus.*

SOLANUM ACULEATISSIMA

Mosaic, Nishimura, U. S. 1918, I, from *N. tabacum.* Transmitted by Fernow (1925) from *L. esculentum, N. tabacum, S. tuberosum, D. stramonium, N. physaloides,* and *N. glutinosa.*

Spotted wilt of tomato, K. M. Smith, England, 1932, I.

SOLANUM ATROPURPUREUM

Leaf roll, Ducomet, France, 1921, N. Same as on *S. tuberosum.*

Curly leaf, Ducomet, France, 1921, N. Same as on *S. tuberosum.*

Frisolée, Ducomet, France, 1922, N. Same as mosaic of *S. tuberosum.*

SOLANUM CAPSICASTRUM

Spotted wilt of tomato, K. M. Smith, 1932, I.

SOLANUM CAROLINENSE

Mosaic, Allard, D. C., 1912, N. Transmitted from *N. tabacum* 1914. Transmitted by Fernow from *L. esculentum, N. tabacum, S. tuberosum.* E. M. Johnson (1930) inoculated with 6 strains of tobacco mosaic.

Ring spot of tobacco, Wingard, Virginia, 1928, I. From *N. tabacum.*

Etch, etch +, severe etch, Johnson, Kentucky, 1930, N.

Healthy potato mosaic, Johnson, Kentucky, 1930, I.

Cucumber mosaic, (3 types). Johnson, Kentucky, 1930, I.

Mosaic, Fernow, N. Y. 1925, I from *N. tabacum* and *S. tuberosum.*

SOLANUM COMMERSONII

Leaf roll, Ducomet, France, 1921, N. Same as on *S. tuberosum.*
Curly leaf, Ducomet, France, 1921, N. Same as on *S. tuberosum.*
"Frisolée," Ducomet, France, 1922, N. Same as potato mosaic.

SOLANUM CILIATUM

Glass house streak, Ainsworth, England, 1933.

SOLANUM DEMISSUM

Spot. Reddick, México, 1932, N. In 1935, Dr. Reddick informed the compiler by letter that this was a virus disease.

SOLANUM DOUGLASII

Curly top of sugar beet, Severin, California, 1929, NI.

SOLANUM DULCAMARA

Mosaic, Gardner, Indiana, 1921. I from *L. esculentum.*
Potato mosaic, J. Henderson Smith, England, 1928, I from *L. esculentum.*
Leaf roll, Dykstra, U. S. 1930, I from *S. tuberosum.*
Spotted wilt of tomato, K. M. Smith, England, 1932, I.

SOLANUM HUMILE

Streak necrosis of tobacco, Schaffnit & Müller, Germany, 1931 I from *S. tuberosum.*
Streak necrosis of potato Schaffnit & Müller, Germany, 1931, I from *S. tuberosum.*
Streak of potato, Schaffnit & Müller, Germany, 1931, I from *S. tuberosum.*
Krausel mosaic, Schaffnit & Müller, 1931, I.
Mosaic, Gardner & Kendrick, Indiana, 1922, I from *L. esculentum.*

SOLANUM LACINIATUM

Spotted wilt of tomato, K. M. Smith, England, 1932, I.

SOLANUM LYCOPERSICON

Aster yellows, Kunkel, N. Y. 1931. I by *C. sexnotata.*
Spotted wilt of tomato, K. M. Smith, England, 1932 I.

SOLANUM MAGLIA

Leaf roll, Ducomet, France, N. Same as on S. tuberosum.
Curly leaf, Ducomet, France, 1921, N. Same as on *S. tuberosum.*
"Frisolée," Ducomet, France, 1921, N. Same as mosaic of *S. tuberosum.*

SOLANUM MARGINATUM

Spotted wilt of tomato, K. M. Smith, England, 1932, I.

SOLANUM MELONGENA

Mosaic, Burger, Florida, 1924, N. Johnson of Kentucky (1930) reported inoculation with 6 strains of tobacco which produced necrotic lesions but not systemic. Also many other plants. (There are earlier records.)

Ring spot of tobacco, Wingard, Virginia, 1928, from *N. tabacum*.

Coarse etch, Johnson, Kentucky, 1930, I.

Mosaic from tobacco, Holmes, New York, 1932.

Spotted wilt of tomato, K. M. Smith, England 1932, I.

Celery virus 1 Wellman, Florida, 1935, I.

SOLANUM NIGRUM

Mosaic, Allard, D. C. 1914, I from *N. tabacum*. Transmitted from *L. esculentum*, by Gardner (1921) and from *N. tabacum, L. esculentum* and *S. tuberosum* by Fernow (1925).

Potato mosaic, J. Henderson Smith, England, 1928, I. from *L. esculentum*.

Ring spot of tobacco, Wingard, Virginia, 1928, I, from *N. tabacum*.

Leaf roll, Dykstra, U. S. 1930, I, from *S. tuberosum*.

Spotted wilt of tomato, K. M. Smith, England, 1932, NI.

Streak necrosis of potato, Schaffnit & Müller, Germany, 1931, I, from *S. tuberosum*.

Tomato mosaic, Schaffnit & Müller, Germany, 1931, I, from *L. esculentum*.

"Krausel" mosaic, Schaffnit, Germany, 1931, I, from *S. tuberosum*.

Streak of potato, Schaffnit & Müller, Germany, 1931, I, from *S. tuberosum*.

Yellow mosaic, Stover & Vermillion, U. S., 1933.

Kromnek of Kat Rives Disease, Moore, South Africa, 1933.

Delphinium mosaic, Washington, 1934, I.

Delphinium stunt, Burnett, Washington, 1934, I.

Celerly virus 1, Wellman, Florida, 1935, I. Symptomless.

SOLANUM NODIFLORUM

Potato mosaic, J. Henderson Smith, England, 1928.

Potato mosaic, J. Henderson Smith, England, 1930, I, from *L. esculentum*.

Aucuba or yellow mosaic, J. Henderson Smith, England, 1930, I.

Spotted wilt of tomato, K. M. Smith, England, 1931.

Mild mosaic, van der Meer, Holland, 1932, I from apparently healthy potatoes.

SOLANUM PSEUDOCAPSICUM

Ring spot of tobacco, Wingard, Virginia, 1928. I, from *N. tabacum.*

Mosaic of tobacco, Holmes, N. Y., 1932, I from *N. tabacum.*

SOLANUM TUBEROSUM

Phloem necrosis, Quanjer, Halland, 1908. N. Described in 1913. Same as leaf roll.

Mosaic. It appear that Orton first observed potato mosaic in Germany in 1911. The first transmission of the disease by inoculation appears to have been Schultz et al in 1919. Reiling (1924) says the disease was known in Germany in 1785. Known in Germany for many years before 1912. Inoculated from *L. esculentum, N. tabacum* and *S. tuberosum* by Fernow, 1925.

Curly dwarf, Orton, U. S. 1914, N. Observed as early as 1912. Known in Germany previous to this date: May be same as mosaic. Goss (1930) said that under some conditions it was impossible to separate curly dwarf and spindle tuber.

Leaf roll, Orton, U. S. 1913, N. Orton said this disease had been known in Germany and Denmark since 1905 and in U. S. since 1911. Quanjer et al said (1919) that this disease should be known as phloem-necrosis or lepto-necrosis. Some workers believe that the potato failures in middle and western Europe in 1770–1780 were due to leaf roll. Reiling 1924) said leaf roll was known in Germany in 1785. Schultz and Folsom (1921) reported a leaf roll which was apparently non-parasitic but transmissible. They stated that it is also called phloem-necrosis and probably widely distributed over the earth. They mention net-necrosis as a possible symptom of leafroll.

Boulent, Mottet, France, 1913, N. Causes failure to germinate.

Spindling sprout, Stewart, N. Y. 1934, N. Stewart and Sirrine 1915) stated that Close and White had described this disease in 1919 and that Macoun of Ottawa Canada claimed to

have seen it in 1905. The "filositée" of France and the "Fadenbildung" and "Fadenkrankheit" of Germany resemble the spindle sprout but it has not been demonstrated that they are the same or that they are caused by a virus. "Filositée" was reported from France by Mottet, 1913.

Net necrosis, Orton, U. S. 1914, N. Atanasoff (1926) said this was a symptom of aucuba mosaic. The symptoms may be due to more than one cause. Quanjer & Elze reported a pseudonetnecrosis in 1929.

Crinkle, Murphy, Canada, 1921, N. Possible same as leaf rolling mosaic. In 1930 Salaman expressed the opinion that this disease was due to a mixture of viruses. This opinion was confirmed by Kenneth M. Smith in 1931. Reiling says that crinkle was known in Germany in 1785.

Russett dwarf. Hungerford, Idaho. 1922. N.

Yellow dwarf, Barrus & Chupp. N. Y. 1922, N. Can be transmitted to *L. esculentum* and *S. nigrum*.

"Frisolée," Ducomet, 1922, N. This is a very old term which Ducomet claims to have been used for mosaic.

Spindling tuber, Schultz & Folsom, Maine, 1922, N. Gilbert (1923) said that spindling sprout was a symptom of leaf roll but not of mosaic. Gilbert (1925) said that Giant hill was a phase of spindle tuber. Goss (1930) said that under some conditions it was impossible to separate spindle tuber and curly dwarf. Known by growers for many year as "running long".

Calico, Hungerford, Idaho, N. Porter (1931) of California proved it to be infectious.

Giant Hill, Gilbert, Vermont, 1923, N. Gilbert (1925) said that Giant hill was a phase of curly dwarf.

Stipple streak, Quanjer, Holland, 1923 or earlier, N.

Uumottled curly dwarf, Schlutz & Folson, Maine, 1923, N.

Witches' broom, Hungerford & Dana, Montana, 1923, N. Young & Morris (1928) stated that the first record of witches' broom was from Montana in 1915 but that it was supposed to be due to Rhizoctonia. Potato witches' broom was first described by Bisby & Tolaas in Minn. Bull. 190 (1928) or by Whipple in Montana, Bull. 130, 1919 as "yellow top degenerates". Transmission by tuber was demonstrated in Idaho 1923. Also attacks tomatoes.

Latent or acronecrosis (top-necrosis), Quanjer, Holland, 1923.

Rugose mosaic, Quanjer, Holland, 1923.

Crinkle, Quanjer, Holland, 1923. Johnson (1929) said that the crinkle was probably the same as Schultz and Folsom rugose mosaic.

Aucuba mosaic, Quanjer, Holland, 1923.

Leaf-rolling mosaic, Schultz & Folsom, Maine, 1923, N.

Crinkle mosaic, Schultz & Folsom, Maine, 1925.

Mosaic, Fernow, N. Y. 1925, I, from *L. esculentum* & *N. tabacum*.

Cucumber mosaic, Doolittle & Walker, Wisconsin, 1927, I. From *C. sativus* and back, transmitted by Johnson of Wisconsin from tobacco mosaic. Confirmed by Blodgett (1927) who got different symptoms on different varieties.

Potato mosaic, Blodgett, N. Y. 1927, N. The symptoms varied on different varieties of potatoes.

Raspberry leaf, Reiling, Holland, 1928, N.

Curly top of sugar beet, Severin, California, 1929, NI.

Phloem necrosis, Quanjer, Thung & Elze, Holland, 1929.

Atanasoff's stipple streak, Atanasoff, Holland, 1929, N.

Kolsiaan stipple streak, Quanjer & Botjes, Holland, 1929, N.

Noordeling stiple streak, Quanjer & Botjes, Holland, 1929, N.

Ersterling stipple streak, Quanjer & Botjes, Holland, 1929, N.

Top necrosis, Quanjer & Botjes, Holland, 1929, N.

Apical leaf, roll, Schultz & Bonde, Maine, 1929, N.

Rugose mosaic, Valleau, Kentucky, 1930, I. Same as spot necrosis of tobacco. Caused by combination of healthy potato virus and veinbanding.

Pseudo-necrosis, Quanjer, Thung & Elze, Holland, 1930, N. Atanasoff, comparing it with some of the earlier figures of net-necrosis identified it with this American disease, and finding it in potato infested with Aucuba mosaic also, considered it as a tuber symptom of this disease. . . . It was later found in several varieties which were free from Aucuba mosaic.

Para-crinkle, Salaman, Redcliff & Le Polley, England, 1930, N.

Ring spot of tobacco, Kentucky, 1930, N.

Spotted wilt of tomato, K. M. Smith, England, 1931, N. I. by grafting.

Moron, Muncie, Michigan, 1931, N.

Virus A. Loughnane, England, 1933, N.

Foliar necrosis, (Virus D.) Bawden, England, 1934, N.

NICOTIANA VILLOSUM

Streak necrosis of potato, Schaffnit & Müller, Germany, 1931, I from *S. tuberosum*.

Streak of potato, Schaffnit & Müller, Germany, 1931, I.

Rugose mosaic, Dykstra, U. S. 1933, I.

Potato mosaic, J. Henderson Smith, England, 1928, I. from *L. esculentum*.

Tomato mosaic, Schaffnit & Müller, Germany, 1931, I from *L. esculentum*.

Krausel mosaic, Schaffnit & Müller, Germany, 1931, I from *S. tuberosum*.

Virus X, K. M. Smith, England, 1931. This virus attacks *Lycopersicon esculentum, N. tabacum, N. glutinosa* and *Datura stramonium*.

STREPTOSOLEN JAMESONII

Spotted wilt of tomato, K. M. Smith, England, 1933, N.

STERCULIACEAE

THEOBROMA sp.

Roncet, Ciferri, Dominican Republic, 1929, N. This disease occurs in Puerto Rico. Not proved to be a virus disease.

TROPAEOLACEAE

TROPAEOLUM MAJUS

Curly top of sugar beet, Severin & Freitag, California, 1933, NI from sugar beet, by *E. tenellus*.

Celery virus 1, Wellman, Florida, 1935, I.

Spotted wilt of tomato, Ainsworth, England, 1933, I.

TROPAEOLUM PEREGRINUM

Curly top of sugar beet, Severin & Freitag, California, 1933, I.

Spotted wilt of tomato, Ogilvie, England, 1935, N.

UMBELLIFEREAE

AMMI MAJUS

Aster yellows, Kunkel, N. Y. 1931, I by *C. sexnotata*.

ANETHUM GRAVEOLENS

Aster yellows, Kunkel, N. Y. 1925, NI, from *C. chinensis*.

Curly top of sugar beet, Severin, California, 1929, I.

Celery virus 1, Wellman, Florida, 1935, I.

ANETHUM GRAVEOLENS DULCE

Mosaic, Poole, New Jersey, 1922, N.

Aster yellows, Kunkel, N. Y. I from *C. chinensis.*

Curly top of sugar beet, Severin, California, 1929, I from sugar beet.

California aster yellows, Severin, California, 1929, NI.

Celerly virus 1, Wellman, Florida, 1935.

ANTRISCUS CEREFOLIUM

Curly top of sugar beet, Severin, California, 1929, I.

APIUM GRAVEOLENS

Mosaic,Doolittle & Wellman, Florida, 1934, I. From *Commelina nudiflora.* In 1934, Wellman described this as Celery virus 1.

Spotted wilt of tomato, Gardner, Tompkins & Whipple, California 1935, I.

Celerly virus 1, Wellman, Florida, 1935, I.

APIUM GRAVEOLENS RAPACEUM

California aster yellows, Severin, California, 1929, I.

Celerly virus 1, Wellman, Florida, 1935, I.

CORIANDRUM SATIVUM

Curly top of sugar beet, Severin, California, 1929, I.

DAUCUS sp.

Yellows, Severin, California, 1930, NI. Also on parsley. Carried by *C. sexnotata.* Severin (1932) demonstrated carrot, parsley and parsnip yellows due to same virus and transmitted by *C. sexnotata* (*C. divisa*). He used *Daucus carota* var. *sativa Apium graveolens* var, *rapacens, Apium graveolens* var. *dulce, Petroselinum hortense* var. *radicosum,* and *Pastinaca* sp. Whetzel reported a yellows disease of carrot in New York in 1929 but it was probably different from the one that Severin studied.

DAUCUS CAROTA

Aster yellows, Kunkel, N. Y. 1931, I.

Celerly virus 1, Wellman, Florida, 1935, I.

DAUCUS CAROTA var. SATIVA

California aster yellows, Severin, California, 1932, NI.

Tobacco mosaic, Grant, Winconsin, 1934, I.

DIDISCUS CAERULENS

Aster yellows, Kunkel, N. Y. 1925, from *C. chinensis.*

DIDISCUS PUSILLUS
Aster yellows, Kunkel, N. Y. 1931.

FOENICULUM DULCE
Curly top of sugar beet, Severin, California, 1929, I.

FOENICULUM VULGARE
Celery virus 1, Wellman, Florida, 1935, I.

LEVISTICUM PALUDAPIFOLIUM
Aster yellows, Kunkel, N. Y. 1931, I.

PASTINACA SATIVA
Aster yellows, Kunkel, N. Y. 1931, I.
California aster yellows, Severin, California, 1932, NI.

PETROSELINUM HORTENSE
Curly top of sugar beet, Severin, California, 1929, N.
California aster yellows, Severin, California, 1932, I. Also on vars. *crispus* and *radicosum*.
Celery virus I, Wellman, Florida, 1935, I.

PINPINELLA ANISUM
Aster yellows, Kunkel N. Y., 1925, IN from *C. chinensis*.

SCANDIX PECTEN-VENERIS
Mosaic, Verplancke, Belgium, 1932, I.
Yellows, Verplancke, Belgium, 1932, I.

TRACHYME CAERULEA
Curly top of sugar beet Freitag & Severin, California, 1929, I.

ULMACEAE

ULMUS sp.
Mosaic, Salmon & Ware, England, 1928. Described in 1925.

ULMUS GLABRA
Mosaic, Rankin, N. Y. 1931, N.

ULMUS PUMILA
Mosaic, Rankin, N. Y. 1931, N.

URTICACEAE

URTICA DIVICA
Mosaic, Ogilvie, England, 1933, N.
Spotted wilt of tomato, Ogilvie, England, 1935, N.

URTICA URENS

Curly top of sugar beet, Carsner, California, 1919.

VALERIANACEAE

CENTRANTHUS CALCITRAPA

Aster yellows, Kunkel, N. Y. 1932, I by *C. sexnotata.*

VALERIANELLA LOCUSTA OLITORIA

Curly top of sugar beet, Severin, California, 1929, I.

VERBENIACEAE

VERBENA VINIFERA

Mosaic, Straviak, Czechoslovakia, 1931, N, Gardner & Whipple, California, 1935,I.

VIOLACEAE

VIOLA CORNATA

Curly top of sugar beet, Freitag & Severin, California, 1933, I.

VIOLA TRICOLOR HORTENSIS

Curly top of sugar beet, Freitag & Severin, California, 1933, N.

VITACEAE

VITIS sp.

Mosaic, Smolak, Czechoslovakia, 1926, N.

Leaf roll, Petri, France, 1929, N. May be same as ''roncet'', ''court noué'', Resigkrankheiten, etc., which have been reported by several workers.

ZINGIBERACEAE

ELETTARIA CARDAMOMUM

Mosaic, Kulkarni, India, 1924, N.

INDEX OF THE VECTORS OF VIRUS DISEASES OF PLANTS

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This index, like that of the host plants of virus diseases, presented far more difficulties than were anticipated by the compiler. This was due to two causes, vis., (1) The compiler did not have access to all the original records, (2) Some of the records were incomplete in that they gave the generic name only, or the common names only.

The original plan was to give the first record only but in some cases it has appeared desirable to give additional records. The names of insects given are, for the most part, those that were used by the authors but in some cases the synonyms (or most recent names) are given in parenthesis. As a result of following the the records of the authors, some genera appear under two names. The compiler has used the latin names of the hosts in some cases and the common names in others. This will be found to correspond in most cases with the original records or with the reviews and abstracts that have been consulted.

The compiler has several records that have been omitted because of incomplete data. If the readers of this index will send their corrections and additions to the writer, they will be used in a supplement.

The compiler wishes to express his thanks to the many workers who have read this manuscript and made suggestions and addition.

ACERATOGALLIA SANGUINOLENTA

1927. Curly top of sugar beet from beet to beet. This insect was latter 1927 found to be *Agallia stricticollis*. Reported by Fawcett in Argentina. Fawcett stated that *Eutettix tenella* does not occur in Argentina.

AGALLIA STRICTICOLLIS

1927. Curly top of sugar beet from *L. esculentum* to *L. esculentum*. Fawcett, Argentina.

AGALLIA SANGUINOLENTA

1934. Yellow dwarf from Potato to potato. Black, N. Y.

ALEYRODIDAE (undetermined)

1931. New virus disease, *N. tabacum* to *N. tabacum,* Storey, South Africa.

1932, Kroepoek, curl and crinkle, *N. tabacum* to *N. tabacum,* Thung, Dutch East Indies.

1932. Mosaic, *Manihot* to *Manihot,* Kufferath and Guésquiere, Africa.

AMPHOROPHORA RUBI

1924. Red raspberry mosaic. Raspberry to raspberry, Bennett, Michigan. Wilcox & Smith, 1924. Bennett of Michigan (1932) reported that this species transmitted both yellow mosaic and red raspberry mosaic.

1930. Yellow mosaic, Raspberry to raspberry, Bennett, Michigan

AMPHOROPHORA RUBICOLA

1927. Red raspberry mosaic, Raspberry to raspberry. Rankin, New York.

AMPHOROPHORA SENSIORATA

1932. Red raspberry mosaic, Raspberry to raspberry, Bennett, Michigan.

ANURAPHIS TULIPAE

1934. Breaking, tupils to tulips, McKenny Huges, England, Transmited in bulbs in stores but not from growing plant to plant.

APHIS sp.

1919. Leaf roll, net necrosis, spindlings tuber, mild mosaic, leaf rolling mosaic, severe mosaic, unmottled mosaic, potato to potato, Schultz, Folsom, Hildebrant & Hawkins, Maine.

1921. Mosaic, beets to beets, Robbins, Colorado.

CUCUMBER APHID

1925. Mosaic, *Physalis pubescens* to *Physalis pubescens* and *C. sativus,* Walker, U. S.

APHIS FABAE (-A. RUMICIS)

1927. Mosaic, sugar beet and spinach to same. Schaffnit, Germany & Böning, Germany.

1927. Mosaic, potato to potato, Elze, Holland.

1929. Mosaic, *Vicia faba* to *P. vulgaris, Anthyllis vulveraria, T. pratense, T. hybridum, T. repens, T. agrarium, Melilotus altisima,* sweet pea and lupins, Merkel, Germany.

1929. Mosaic, Lupins to peas, sweet peas and *V. fabae,* Merkel, Germany.

1919. Mosaic. *Phaseolus vulgaris* to *V. fabae* and *Lupins,* Germany.

1929. Leaf roll, *S. tuberosum* to *S. tuberosum,* Elze, Holland.

1930. Mosaic. Spinach to spinach. Volk, Germany.

1930. Mosaic, Sugar beet to *Chenopodium album, Amaranthus retroflexus* and *Sonchus arvensis.* Novinenko, Ukraine.

APHIS FORBSEI (-MYZUS FRAGAEFOLII)

1928. Dwarf, *Fragaria* sp. to *Fragaria* sp., Plakidas, U. S.

APHIS GOSSYPII

1916. Mosaic, *C. sativus* to *C. sativus,* Doolittle & Jagger, working independently, U. S.

1925. Mosaic, *Micrampelis lobata* to *C. sativus.* Doolittle and Walker, U. S.

1928. Mosaic, *Gladiolus* to *Gladiolus,* Dosdall, Minnesota.

1931. Mosaic, *Commelina nudiflora* to celery and cucumber, Doolittle, U. S.

1932. Dwarf, Onion to onion, Drake, Tate & Harris, Iowa.

1934. Stunt, Lily to lily, Pape, Germany.

1934. Mosaic, *C. nudiflora* to *Apium graveolens* and *P. logascae,* Doolittle & Wellman.

1934–1935. Celery virus 1, Celery and *C. nudiflora* to many host species, Wellman, Florida.

APHIS LABURNI (-A LEGUMINOSAE)

1925. Rosette, *Arachis hypogea* to *A. hypogea,* Storey & Bottomley. South Africa. "Krulziekte" of Java (Rutgers 1913) may be same as rosette, bunching and bunting. Also reported by Brooks in Gambia.

1927. Mosaic, Lily to lily, Ogilvie, Bermuda.

APHIS MAIDIS

1920. Sugar cane mosaic. *Saccharum officinarum* to *S. officinarum,* Brandes, U. S.

1920. Corn mosaic, *Zea mays* to *Zea mays.*

1929. Corn mosaic, *Sorghum arundinaceum* to *S. arundinaceum,* Storey, South Africa.

1929. A virus disease of grasses that does not attack sugar cane (grasses to grasses), Storey, South Africa.

APHIS RHAMNI

1927. Leaf roll potato to potato, Elze, Holland.

1927. Crinkle potato to potato, Elze, Holland.

1928. Mosaic *Trifolium repens* to potato, van der Meulen, Holland.

APHIS RUBIPHILA

1922. Mosaic, Raspberry to raspberry, Dickson, Canada, Dickson stated that the insect was not determined but "it is highly probable that it was *Aphis rubiphila.*" Rankin reported proof in 1923 but in 1931 stated that yellow mosaic was not transferred by *A. rubiphila.* Bennett (1932) said that the literature regarding *Aphis rubiphila* was contradictory and in a letter to the compiler (Nov. 20, 1934) states positively that this insect is not a vector of mosaic but that it is a vector of curl. Grainger and Angood (1931) of England reported positive results in transferring mosaic from wild raspberry (*Rubus idaeus*) to same.

1922. Yellow leaf curl and mosaic, red raspberry to red raspberry. Rankin, Hockey and McCurry, Canada. Rankin said later that this insect does not transmit mosaic.

APHIS RUMICIS (-A. FABAE)

1918. Mosaic, or blight, Spinach to spinach, McClintock & Smith, Virginia.

1930. Deformed leaf, Beets & Spinach to beets & spinach, Böning, Germany.

1930. Deformed leaf, *Rumex obstusifolius* & *R. crispus* to *R. obtusifolius* & *R. crispus,* Böning, Germany.

1930. Mosaic, Beans to bean, Fajardo, Wisconsin.

1932. Yellow dwarf, Onion to onion, Drake, Harris & Tate, Iowa.

APHIS SAMBUCI

1930. Dwarf, *Sambucus nigra* to *S. nigra,* Blattny, Czechoslovakia.

APHIS SPIRACEAE

1931. Witches' broom, *Holodiscus discolor* to *H. discolor,* Zeller, Oregon.

ASTEROCHITON VAPORARIORUM

1927. Mosaic, potato to potato, K. M. Smith, England. Some evidence in greenhouse.

BALCLUTHA MBILA (-CICADULINA MBILA)

1924. Streak of sugar cane. Sugar cane and corn to sugar cane and corn, Storey, S. Africa.

BEMISIA GOSSYPIPERDA

1931. Leaf curl. Cotton to cotton, Kirkpatrick, Sudan, Leaf curl and crinkle are the same.

1932. Leaf curl, *N. tabacum* to *N. tabacum*. Storey, South Africa. Disease is probably same as "kroepoek". Also occurs on *Zinnia elegans*. Vector discovered by Storey of South Africa and Thung at Klaten at about same time.

BEMISIA MOSAICIVECTI

1932. Mosaic, Cassava to cassava. Ghésquiere, Belgian Congo.

BREVIOCORYNE BRASSICAE

1930. Mosaic, Crucifers to crucifers, Clayton, New York.

CALOCORIS BIPUNCTATUS

1923. Leaf roll, potato to potato, Murphy, Ireland.

CALOCORIS FULVOMACULATUS

1928. Squirt mosaic, Hops to hops, Blattny, Czechoslovakia.

CAPITOPHORUS FRAGARIAE

1934. Stunt, *Fragaria* sp. to *Fragaria* sp. Chamberlain, New Zealand.

CAPITOPHORUS TETRARHODUS

1927. Dwarf. Blackberry to blackberry, Zeller, Oregon.

CERATONIA TRIFURCATA

1924. Mosaic. Cowpea to cowpea, E. C. Smith, California.

CHLORITA FLAVESCENS

1930, Virus disease. Hops to hops, Blattny. In Czechoslovakia (similar to nettle head in England).

1930. "Krausel," Hops to hops, Blattny, Czechoslovakia.

CICADULA SEXNOTATA (-CICADULINA SEXNOTATA)

1928. Aster yellows. Aster and celery to aster and celery, Kunkel in New York.

1928. Aster yellows, Asters to parsnip and parsley, Kunkel, New York.

1928. Mosaic, Sugar beet to sugar beet, Novinenko, Ukraine.

1930. Aster yellows, Carrot & spinach to carrot & Spinach, Kunkel, New York.

1931. Aster yellows. From Asters to *Humulus japonicus, Monolepis chenopodioides, Abornia umbellata* (var. *grandiflora*), *Tetragonia expansa, Dianthus alpinus Herniaria glabra, Lychnis coronaria, L. viscaria, Polycarpon tetraphyllum, Tunica saxifraga, Vaccaria segitalis, Adonis aestivalis; Papaver nudicaule, Cheiranthus, allionii, Malcomia maritima, Radicula sylvestris, Potentilla monspeliensis, Limnanthes douglasii, Datisca cannabina, Helianthemum chamaeiistus, Blumenbachia hieronymi, Cajophora lateritia, Clarkia, elegans, Ammi majus, Daucus carota, Didiscus pusillus, Levisticum paludapifolium, Pastinaca sativa, Armeria alpina, Limonium, suworowi, Anagallis linifolia, Vinca rosea, Gilia densiflora, G. tricolor, Polemonium coeruleum, Phacelia campanularia, P. congesta, P. viscida, P. whitlavia, Anchusa barrelieri, A. capensis, Dracocephalum ruyschiana, Physostegia virginica, Browallia demissa, Hyoscyanus niger, Nicotiana rustica, Petunia hybrida, Alonsoa warscewiczi, Collinsia bicolor, Linearia cymbalaria, L. maroccana, Maurandia scandens, M. lophospermum, Verbascum hybridum, Veronica peregrina, Didymocarpus hosfieldii, Thunbergia alata, Plantago alpina, P. fuscescens, P. psyllium, Centranthus calcitrapa, Lobelia erinus* (var. *compacta*) *Acroclinium roseum, Anthemis tinctoria, Arclotis grandis, Cacalia hastata, Carthamus tinctorius, Charieis heterophylla, Chrysanthemum cineranifolium, Cineraria hybrida, Cirsium oleraceum, Chadanthus arabiscus, Coreopsis lanceolata, Cosmos bipinnatus, Cousiana hystrix, Echinops dahuricus, Emilia flammea, Erigeron glabellus, E. linifolius, E. speciosus, Ethulia conyzoides, Eupatorium urticaefolium E. perfoliatum, Felicia aethiopica,* var. *glandulosa, F. amelloides, Filago germanica, Flaveria repanda, Galinsoga parviflora, Grindelia squarrosa, Hedypnois cretica, Helenium autumnale, H. biglovii, H. hoopesii, H. nudiflorum, Heliopsis nudiflorum, H. laevis, Helipterum manglesii, Hieracium alpinum, Koelpinia linearis, Logascaea mollis, Leontodon autumnalis, Leontopodium alpinum, Leptosyne stillmani, Lindheimeria texana, Lonas inodora, Mulgedium alpinum, Parthenium integrifolium, Petasites albus, Rudbeckia hirta, Sanvitalia procumbens, Schukuhria abretanoides, Scolymus hispanicus, Spilanthes acmella, Thelesperma hybridum, Tolpis barbata, Tragopogon fluccosus, Tridax tribolata, Ursinia anthemiodes, Zacyintha verrucosa, Zinnia multiflora.* By Kunkel, New York.

1932. California celery yellows. Celery to celery, Kunkel, New York. This vector could not transmit the New York yellows to celery.

1932. Yellow dwarf,. Onion to onion, Drake, Tate & Harris, Iowa.

CICADULA MBILA. (BALCLUTHA MBILA)

1925. Streak. Sugar cane to sugar cane, Storey, South Africa.

1930. Streak. Sugar cane to *Eleusine indica, Zea mays, Digitaria horizontalis,* Storey & McClean, South Africa.

DACTYLOPINUS sp.

1925. Mosaic. Cucumber, *Micrampelis lobata* to *cucumber.* Doolittle & Walker, U. S.

DIABROTICA DUODECIMPUNCTATA

1925. Mosaic. Cucumber, *Micrampelis lobata* to *cucumber.* Doolittle & Walker, U. S.

DIABROTICA VITTATA

1925. Mosaic. Cucumber to cucumber, Doolittle & Walker, U. S.

DISCONYCHA TRIANGULARIS

1930. Spindling tuber, potato to potato, Goss, Nebraska.

EMPOASCA sp.

1930. Mosaic. Bean to bean, R. C. Smith and Barker, Haiti. It has not been definitely proven that this disease is due to a virus.

EMPOASCA DEVASTANS

1930. Leaf crinkle. Cotton to cotton, Afzal reported this insect as a cause of the disease in Sudan.

EMPOASCA FABAE

1931. Leaf roll, potato to potâto, Cleveland, Indiana.

EMPOASCA (CHLORITA) FLAVESCENS

1928. Mosaic. Sugar beet to sugar beet, Novinenko, Ukraine.

EPITRIX CUCUMERIS

1930. Spindling tuber, potato to potato, Goss, Nebraska.

1930. Unmottled curly dwarf, potato to potato, Goss, Nebraska.

1931. Leaf roll, potato to potato, Cleveland, Indiana. (To a limited extent.)

ERIOPHYES RIBIS

1924. Reversion, etc., *Ribes* to *Ribes,* Massee, England.

EUPTERY AURATUS

1927. Mosaic, potato to potato, K. M. Smith, England. (Some evidence.)

EUPTERIX AURATUS

1926. False blossom, Cranberry to cranberry, Dobroscky, U. S.

1928. Mosaic, Sugar beet to sugar beet, Novinenko, Ukraine.

EUTETTIX TENELLUS

1905. Curly top of sugar beet sugar beet to sugar beet. Ball was the first to call relationship of this disease and this insect but at that time the disease was not known to be due to a virus.

1925. Curly top of sugar beet, *Phaseolus vulgaris* to *P. vulgaris,* Carsner, Calif.

1927. Curly top of sugar beet to tomato.

1927. Curly top of sugar beet to squash, McKay & Dykstra, Oregon, Washington and Idaho.

FRANKLINIELLA sp.

An obscure and destructive virus disease of tobacco in South Africa was reported by E. S. Moore (1932) to be transmitted by *Frankliniella* sp. Distinctive disease of *Datura stramonium,* two species of *Physalis* and *Nicandra physaloides* are transmitted by same insect.

1933. Virus disease, tobacco to tobacco, Moore, South Africa. This disease may be the same as spotted wilt of tomato.

FRANKLINIELLA INSULARIS

1930. Spotted wilt of tomato, tomato to tomato. Samuel, Bald & Pittman. Australia.

ILLINOIA. (MACROSIPHUM) PISI

1934. Mosaic, *Lucerne alfalfa* to *L. alfalfa,* Weimer, California.

ILLINOIA SOLANIFOLII (-MACROSIPHUM GEI)

1928. Breaking, Tulips to tulips, McKay, Brierley & Dykstra, U. S.

1932. Leaf rolling mosaic, potato to potato, McKay & Dykstra, Oregon.

1932. Leaf roll, potato to potato, McKay & Dykstra, Oregon.

1933. Mosaic, Bulbous Iris to bulbous Iris, Brierley & Mc Whorter, U. S.

LEPTINOTARSE DECEMLINEATA

1930. Spindling tuber, Potato to potato, Goss, Nebraska.
1930. Unmottled curly dwarf, Potato to potato, Goss, Nebraska.

LINCUS sp.

1934. Phloem necrosis, coffee to coffee, Stahel, Suriname. (Transmission suspected).

LYGUS PRATENSIS

1930. Spindling tuber. Potato to potato, Goss, Nebraska.
1930. Unmottled curly dwarf, Potato to potato, Goss, Nebraska.

MACROPIS TRIMACULATA

1932. Peach yellows, Peach to peach. Kunkel, New Jersey, Manns of Delaware has given additional evidence on this subject.

MACROSIPHUM sp.

1927. Mosaic, beets and spinach to beets and spinach, Schaffnit, Germany, Böning, Germany.
1928. Mosaic. Potato to beets, van der Meulen, Holland.

MACROSIPHUM GEI. (-M. SOLANIFOLII)

1927. Mosaic, Potato to potato, K. M. Smith, England.
1930. Breaking, tulips to tulips, McKenny Hughes (less important than *Myzus persicae*). England.
1930. Red streak break, McKenny Hughes, England.
1931. Leaf roll, Potato to potato, Whitêhead, England.
1932. Yellow dwarf, Onion to onion, Drake, Tate & Harris, Iowa.
1934. Self breaking, tulips to tulips, McKenny Hughes, England.
1935. Virus disease, *Primula obconia* to *Datura stramonium*, K. M. Smith, England.

MACROSIPHUM PISI.

1929. Mosaic, *Trifolium pratense* to *P. vulgaris* & peas. Sweet peas to *P. vulgaris* & Lupins. Peas to *P. vulgaris,* sweet pea, *T. pratense* & Lupins, *Vicia faba* to *P. vulgaris,* sweet pea, *Anthyllis vulneraria, T. pratense, T. hybridum, T. Agrarium, Melilotus altissima & Lupins,* Sweet pea to peas & *T. pratense, T. pratense,* Peas to *V. faba.* Lupins to sweet pea & *V. faba.* Merkel, Germany.
1930. Mosaic of cucumber (Spinach blight). Spinach & cucumber to Spinach y cucumber. Hoggan, Wisconsin.

1930. Mosaic. Spinach to Spinach, Volk, Germany.
1935. Mosaic, Pea to broad bean, garden pea, sweet pea and Canadian field pea. Osborn, New Jersey.

MACROSIPHUM SOLANIFOLII (-M. GEI)

1918. Blight or mosaic, Spinach to spinach, McClintock & Smith, Virginia.
1919. Mosaic, Potato to potato, Schultz, Folsom, Hildebrant & Hawkins, Maine.
1922. Mosaic bean to bean, Nelson in Michigan and Fajardo in Wisconsin working separately.
1923. Mild mosaic, alone and in combination with leaf roll and spindling tuber. Potato to potato. Schultz & Folsom, Maine.
1930. Cucumber mosaic, Tobacco to *Spinacia oleoracea,* Hoggan Wisconsin.
1930. Cucumber mosaic, Tobacco to tobacco and other *Solanaceae,* Hoggan, Wisconsin.
1933. Rugose mosaic. Potato to potato, Koch, Wisconsin.
1934. Tobacco mosaic, Tobacco to many *Solanaceous* plants, Hoggan, Wisconsin.
1933. Cucumber mosaic, Cucumber to Spinach and tobacco,

MELANOPLUS sp.

1928. Spindling tuber, Potato to potato, Goss, Nebraska.
1928. Unmottled curly dwarf, potato to potato, Goss, Nebraska.

MOONIA ABIMACULATA

1933. Spike disease, *Santalum album* to *S. album.*

MYZUS CIRCUMFLEXUS

1931. Cucumber mosaic. From tobacco and tomato, Hoggan, Wisconsin.
1931. Leaf roll. Potato to potato, Whitehead, England.
1932. Crinkle mosaic, Potato to potato, McKay & Dykstra, U. S.
1933. Virus A. Potato to potato, Loughnane, Ireland.

MYZUS FRAGAEFOLII

1927. Witches' broom, strawberry to strawberry, Zeller, Oregon.
1927. Xanthosis or yellow, strawberry to strawberry, Plakides, California.

MYZUS PELARGONII

1928. Breaking, Tulips to tulips, McKay, Brierley & Dykstra, U. S.

1932. Leaf rolling mosaic, Potato to potato, McKay & Dykstra, U. S.
1932. Leaf roll, Potato to potato, McKay & Dykstra, U. S.

MYZUS PERSICAE

1917. Mosaic, Tobacco to tobacco, Allard, D. C.
1918. Mosaic, Lettuce to lettuce, Jagger, U. S.
1919. Mosaic, Potato to potato, Schultz, Folsom, Hildebrant & Hawkins, Maine.
1921. Mosaic, Chinese mustard and turnip to Chinese mustard and turnips, Schultz, Maine.
1921. Mosaic, Beets to beets, Robbins, Colorado.
1923. Leaf roll, Potato to potato, Murphy, Ireland.
1927. Mosaic. Potato to potato, K. M. Smith, England.
1927. Crinkle, potato to potato, Elze, Holland.
1928. Mosaic, beet to beet, van der Meulen, Holland.
1928. Mosaic. Potato to *Trifolium repens*, van der Meulen, Holland.
1928. Breaking, Tulips to tulips, McKay, Brierley & Dykstra, Oregon.
1929. Cucumber mosaic, Tobacco to susceptible *Solanaceae*, Hoggan, Wisconsin.
1929. Internal parenchyma mosaic. Potato to potato, Quanjer, Thung & Elze, Holland.
1929. Potato mosaic. Potato to tobacco, K. M. Smith, England. Produced symptoms which he believed to be the same as tobacco ring spot in United States.
1930. Mosaic, Bean to bean, Fajardo, Wisconsin.
1930. Mosaic, Spinach to spinach, Volk. Germany.
1930. Deformed leaf, Spinach to spinach, Böning, Germany.
1930. Deformed leaf, *Rumex obtusifolius* & *R. Cripus* to *R. obtusifolius* & *R. crispus*, Böning, Germany.
1930. Cucumber mosaic. Tobacco to Spinach and spinach to spinach, Hoggan, Wisconsin.
1930. Fern leaf (Cucumber mosaic) tomato to tomato, Mogendorff.
1930. Red streak, Tulip to tulip, McKenny Hughes, England. On the variety, President.
1930. Red streak, Tulip to tulip, McKenny Hughes, England.
1930. 'Crinkle, Potato to potato, K. M. Smith, England. On the variety, President.
1930. Leaf roll, Potato to *Capsicum* sp. *Datura stramonium, D.*

tatula, Lycopersicon esculentum, Solanum dulcamara, S. nigrum. Dykstra, U. S.

1930. Pseudonetnecrosis, Potato to potato, Quanjer, Thung & Elze, Holland.

1931. Mosaic, Tomato to tomato, Cleveland, Indiana. Not first record.

1931. Tobacco mosaic, tobacco to many *Solanaceae,* Hoggan, Wisconsin.

1932. Yellow dwarf, Onion to onion. Drake, Tate & Harris, Iowa.

1932. Hy II, III and IV. *Hyoscyamus niger.* to *H. niger.* Halmilton, England, K. M. Smith says that these viruses are same as viruses X and Y.

1932. Rugose mosaic, Potato to potato, McKay & Dykstra, U. S.

1932. Leaf rolling mosaic, Potato to potato, McKay & Dykstra, U. S.

1933. Mosaic, Dahlia to dahlia, Brierley, New York.

1933. Virus A. Potato to potato, Loughnane, Ireland.

1933. Rugose mosaic. Potato to potato, Koch, Wisconsin.

1931. Breaking. Tulips to tulips. McKenny Hughes, England.

1933. Cucumber mosaic, cucumber to spinach. Hoggan, Wisconsin.

1933. Cucumber mosaic, Tobacco and Spinach to spinach., Hoggan, Wisconsin.

1934. Mosaic, Bulbous iris to bulbous iris, Brierley & McWhorter, U. S.

1934. Yellow dwarf, Potato to potato, Koch, Wisconsin.

1934. Self breaking, Tulips to tulips, McKenney Hughes, England.

MYZUS PSEUDOSOLANII

1925. Mosaic, Potato to potato, Murphy & McKay, Ireland.

1931. Cucumber mosaic, Tobacco to tomato, Hoggan, Wisconsin.

1934. Tobacco mosaic, Tobacco to many Solanaceae., Hoggan, Wisconsin.

1934. Narrow leaf, Tomato to tomato, Chamberlain, New Zealand.

NEPHOTETTIX APICALIS var. CINCTICEPS

Dwarf, Rice to rice. This is the first record of transmission of a virus disease by an insect, and was made by Takata. It was at first supposed that the insects were the cause of the disease

but later studies by Takami (Journ. Jap. Agri. Soc. No. 241: 22–30, 1901, (in Japanese) reported that it was a carrier.

ORTHESIA INSIGNIA

1932. Virus disease, *Ephiphyllum truncata* to *E. truncata*. Blattny & Vukulov, Czechoslovakia.

ORTHEZIA UTRICAE

1924. Mosaic. *Clerodendron fragans* to *C. fragans*. Blattny, Czechoslovakia.

ORTHOTYLUS FLAOSPARUS

1928. Virus disease, Sugar beet to sugar beet, Novinenko, Ukranine.

PENTALONIA NIGRONERVOSA

1925. Bunchy top, Banana to banana, Goddard, Australia.

1926. Bunchy top, Manila hemp (*Musa textilus*) to Manila hemp. Ocfemia, Philippine, Islands.

1930. New virus disease, banana to banana, Magee, Australia.

PEREGRINUS MAIDIS

1922. Mosaic, Corn to corn. Kunkel, Hawaii. This mosaic is different from sugar cane mosaic. This insect does not transmit sugar cane mosaic. May be same disease as corn stripe of Stahl.

1927. Corn stripe, Corn to corn, Stahl, Cuba.

PERKINSIELLA SACCHARICIDA

1933. Fiji disease, Sugar cane to sugar cane. Mungomery & Bell, Australia.

PERKINSIELLA VASTATRIX

1933. Fiji disease, Sugar cane, to sugar cane. Ocfemia, Hurtado & Hernández, Philippine Island.

PIESMA (ZOSMENUS) QUADRATA

1928. Leaf curl, Beets to beets, Böning, Germany.

POECILOSCYTUS COGNATUS

1928. Mosaic, Sugar beet to sugar beet. Novinenko, Ukraine.

PROTOPARCE SEXTA

1925, Mosaic, Tobacco to tobacco, Elmer, Iowa.

PSEUDOCOCCUS CITRI

1928. Mosaic, Tobacco and tomato to tobacco and tomato, Olitsky, U. S.

PSEUDOCOCCUS MARITIMA

1925. Mosaic, Many hosts to many hosts. Elmer, Iowa.

RHOPALOSIPHUM (MYZUS) PERSICAE

1918. Blight. Spinach to spinach, McClintock, Virginia.

RHOPALOSIPHUM PRUNIFOLIA

1932. Yellow dwarf. Onion to onion. Drake, Tate & Harris, Iowa.

RHOPALOSIPHUM RUBI

1927. Virus disease, Raspberry to raspberry, Blattny, Czechoslovakia.

SYSTENA ELONGATA

1930. Spindling tuber, Potato to potato, Goss, Nebraska.

1930. Unmottled dwarf, Potato to potato, Goss, Nebraska.

TETRANYCHUS TELARIUS

1931. Leaf roll, tomato to tomato to some extent. Cleveland, Indiana.

THRIPS MINUTA var. PUTEMANSI

1926. Mosaic,Sugar cane to sugar cane. Costa Lima, Brazil.

THRIPS TABACI

1927. Spotted wilt of tomato. Tomato to tomato, Pittman, Australia K. M. Smith (1932) transmitted this disease by this insect to many hosts in England, Gardner & Whipple (1934 and 1935), transmitted the disease by this insect to many hosts in California.

1931. Yellow spot, Pineapple to pineapple. Lindford, Hawaii

1931. Streak and necrosis. (Same as pineapple yellow spot). *Pisum sativus* to *Emilia flammea* (-*E. sagittata*). Linford, Hawaii.

1931. Leaf roll, Potato to potato to a limited degree. Cleveland, Indiana.

1932. Spotted wilt of tomato, Tobacco to tomato and the reverse, K. M. Smith, England.

1932. Spotted wilt of tomato, *Datura stramonium* to tomato and the reverse. K. M. Smith, England.

ZYGINA PALLIDIFRONS

1927. Mosaic, Potato to potato, K. M. Smith, England.

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